GEOPHYSICAL REPORT ON ELECTROMAGNETIC AND INDUCED POLARIZATION / RESISTIVITY SURVEYS

Carried out at:

MOUNT POLLEY MINE PROPERTY
CLAIM BLOCK PM-7 (Tenure #206452)

CARIBOO MINING DISTRICT, BRITISH COLUMBIA

N.T.S.: 93A / 12W
LATITUDE: 52°34.2' N LONGITUDE: 121°37.8'W
UTM: 592,800E 5,825,400N Zone 10 NAD83

For:

MOUNT POLLEY HOLDING COMPANY LIMITED – Claim Owner

IMPERIAL METALS CORPORATION – Operator

By:

ASSOCIATED MINING CONSULTANTS LTD.

Submission Date: 25 May, 2005

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1.0 INTRODUCTION

A geophysical exploration program was carried out by Associated Mining Consultants Ltd. (AMCL) in the Wishbone (Northeast Zone) area of the Mount Polley Mine Site in late 2003 and early 2004. The exploration program had two objectives: first, to determine which of three geophysical methods was most capable of detecting a known ore body; and second, to use that method to explore for other ore bodies on the property. The three methods investigated were: large-loop time-domain electromagnetics (TEM); horizontal-loop fixed-frequency electromagnetics (HLEM); and induced polarization (IP).

This work was carried out in the field on claim PM-8 (tenure #206453). This claim was converted to a mining lease (lease #410495) on 29 September, 2004. The work was therefore registered on adjoining claim PM-7 (lease #206552). The claims are owned by Mount Polley Holding Company Limited, and are operated by Mount Polley Mining Corporation.

Two electromagnetic test surveys were carried out, comprising 2.5 line-km. Both TEM and HLEM surveys were conducted over portions of a known ore body. The motivation for the survey arose from an examination of selected core in Imperial Metals' Vancouver office. From a visual inspection, the mineralization, although not appearing to be massive, did appear to be electrically connected over substantial distances. Therefore the objectives of the surveys were to determine whether the ore body could be detected using these electromagnetic methods, which typically respond well to electrically conductive ore bodies. The results showed a weak HLEM response.

An induced polarization (IP) survey was undertaken by Discovery Geophysics Inc. under the direction of Associated Mining Consultants Ltd. (AMCL) in February and March of 2004. The survey was conducted in the Wishbone Area, both in the clear-cut area and in the surrounding forest. The objectives of the investigation were to acquire IP data over the known Wishbone-Area mineralization, and to extend the mapping outside the known zone to explore for other deposits or extensions to the known deposit.

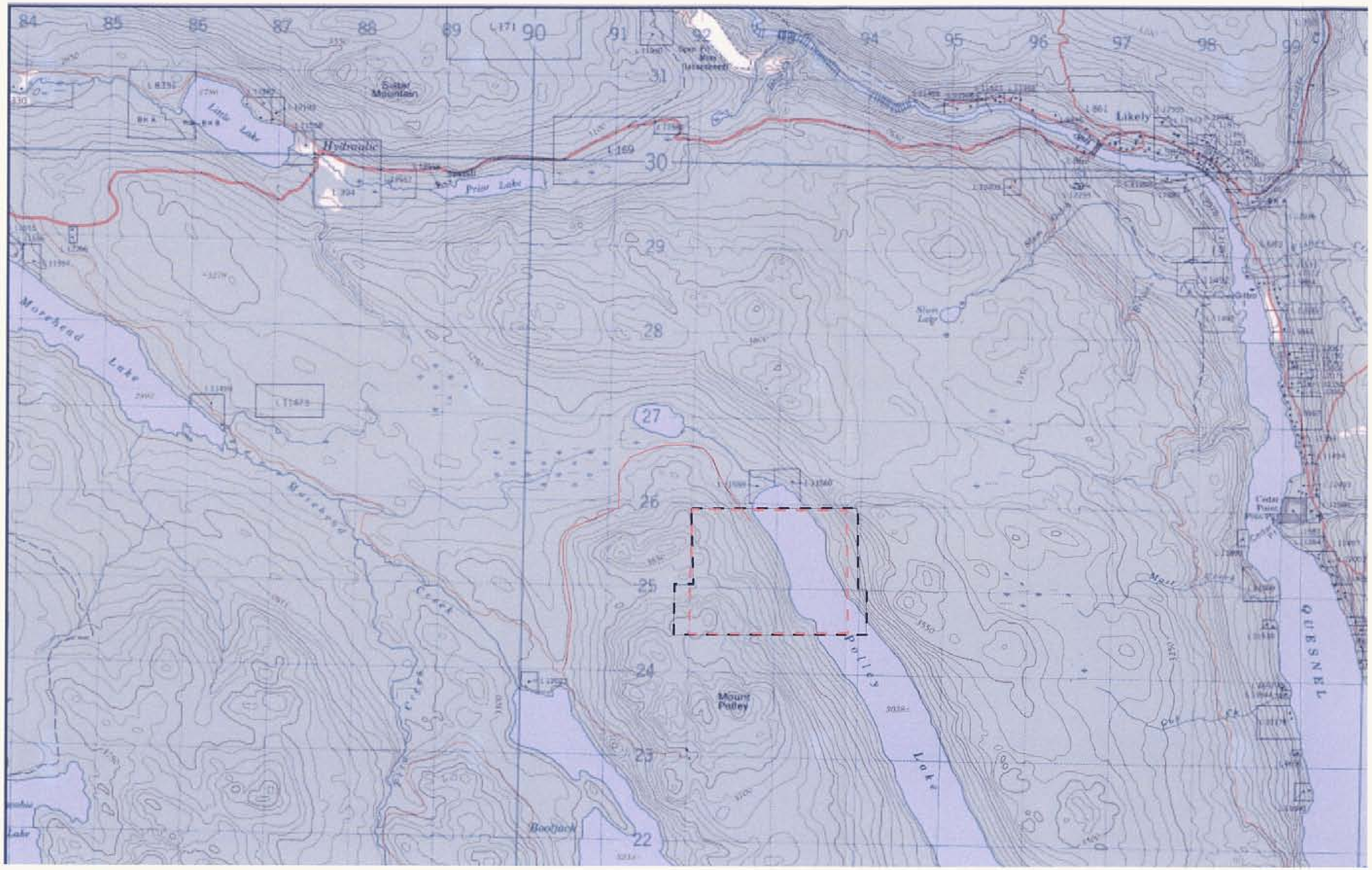
Thirty-five IP lines, comprising 51.3 line-km, were acquired. The results suggest that IP methods can easily image portions of the known ore body. Numerous high-chargeability anomalies, and one low-resistivity anomaly were detected.

In addition to the geophysical work performed, 51.55 line-km were cleared during the survey.

1.1 Site Description

Figure 1a shows the site location, in the Wishbone area in the northeastern portion of the Mount Polley Mine site. Access is by four-wheel-drive vehicle either from the north along the Frypan road, or from the south using a spur road off the Polley Lake road. Both of these roads are accessible from the main Bootjack Lake road that connects the mine site to the provincial highway. The site topography is characterized by a gentle west-to-east slope. Portions of the area has been clear-cut, either recently in preparation for drilling, or within the past ten years.

True North (Grid North - 59')
Grid North
Magnetic North (Grid North + 21.5')



5,830,000 m N

5,825,000 m N

585,000 m E

590,000 m E

595,000 m E

600,000 m E

Scale = 1:50,000

0 m 1000 m 2000 m 3000 m

Legend

Approximate location of Geophysical Surveys

MP-08 Claim Boundary

Note: Topographic image from NTS Map Sheet 93A/12.
UTM Grid: NAD 1927, Zone 10

Fig. 1a: Geophysical Survey Location

Imperial Metals
Mount Polley Property

IMC
Associated Mining Consultants Ltd.

Figure 1b shows the locations of the TEM and HLEM lines. Lines were acquired in an N60°E orientation, at a nominal line spacing of 50 m. Part of the ore body lies beneath lines B, C, D, E, and F.

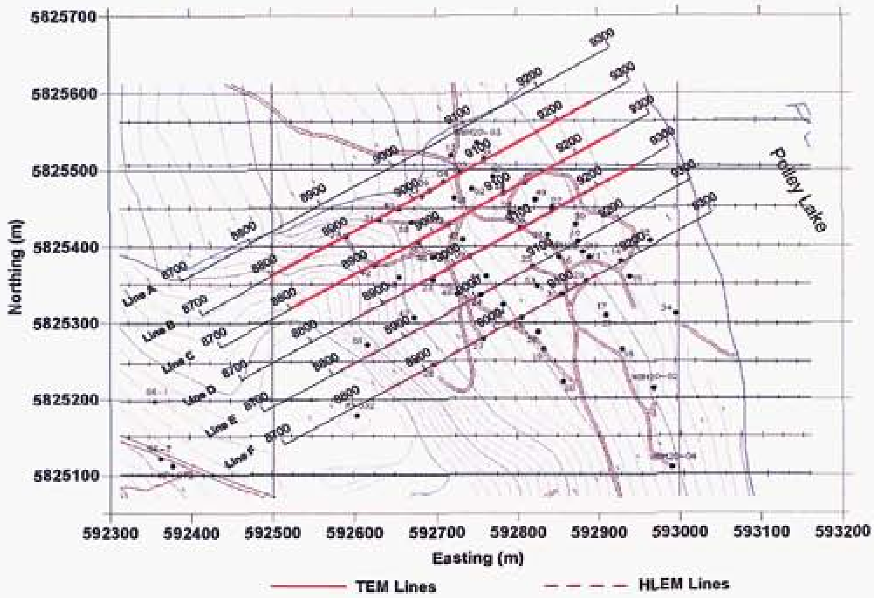


Figure 1b: TEM and HLEM line locations in the Wishbone area

Figure 1c shows the locations of the IP lines. Thirty-two lines were acquired in an east-west orientation, at a nominal line spacing of 50 m, spanning local Northings 4650 m to 6200 m, and local Eastings 1725 m to 3625 m. As the survey was conducted during the winter months, most of the lines extended onto the lake ice, either partly or completely across Polley Lake.

2.0 GEOPHYSICAL METHODS

2.1 Time-Domain Electromagnetics (TEM)

The transient electromagnetic (TEM) profiling method is a time-domain technique that resolves large-scale variations in the resistivity of the earth's subsurface. Instrumentation consists of a transmitter to impart current to a loop of wire laid on the ground surface, and a receiver coil and module to measure and record the resulting magnetic field (Figure 2).

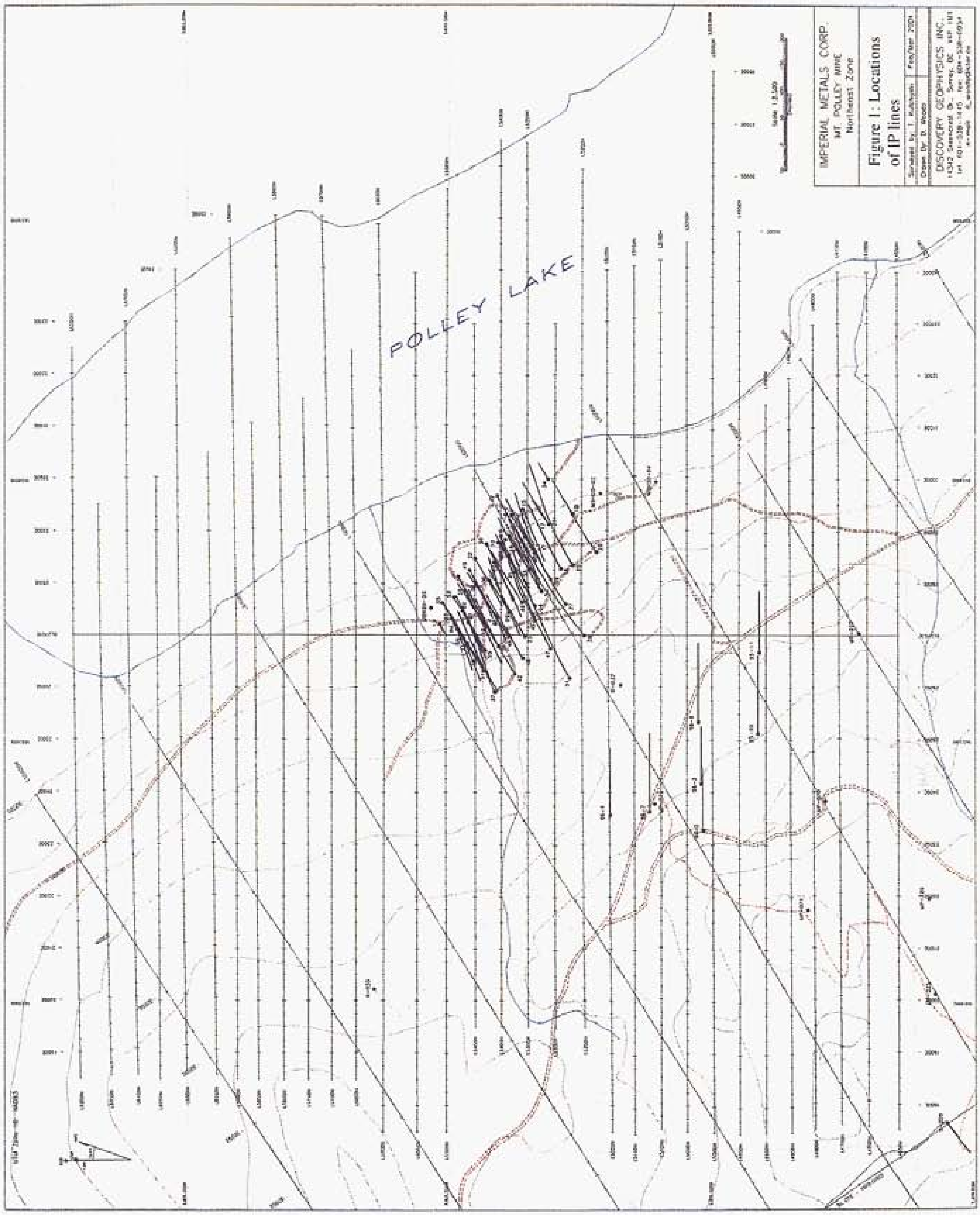


Fig. 1c: Locations of IP Lines. The IP lines are oriented east-west.

Briefly, the TEM resistivity sounding procedure consists of energizing the transmitter loop by successive current pulses. While the current is constant, the magnetic field is invariant. The process of abruptly reducing the transmitter current to zero induces, in accordance with Faraday's law, a short-duration electromagnetic pulse that propagate into the ground. This EM pulse, in turn, induces a loop of electrical current to flow in the subsurface in the immediate vicinity of the transmitter wire. Ground resistivity is such that the amplitude of the resulting current decays with time, thereby inducing a secondary magnetic field at an increasing distance from the source current. As a result, the induced current loops moves downwards and away from the transmitter loop, becoming attenuated with increasing distance and time. The secondary magnetic field, measured over time at the ground surface, is dependent upon the electrical properties of the subsurface. In this manner, lateral and vertical variations in electrical properties may be resolved.

In TEM profiling, lateral resistivity variations are determined by keeping the transmitter loop fixed, and moving the receiver at constant intervals away from the transmitter.

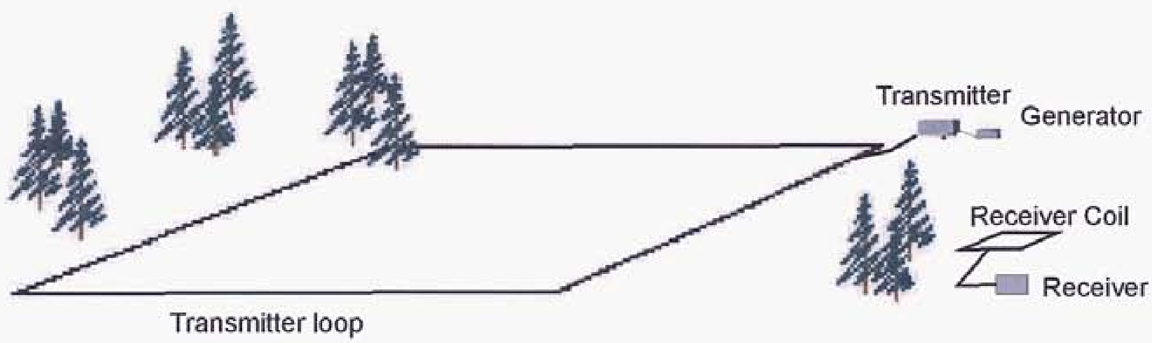


Figure 2: TEM Profiling Configuration

The ability of the TEM profiling method to delineate electrically conductive ore bodies is dependent on the degree of contrast in the electrical properties of neighbouring lithologies, target size, and target depth. The resistivity of a target is a determining factor in its ability to be detected by surficial electromagnetic methods. Figure 3 illustrates the resistivity range of some general geological materials.

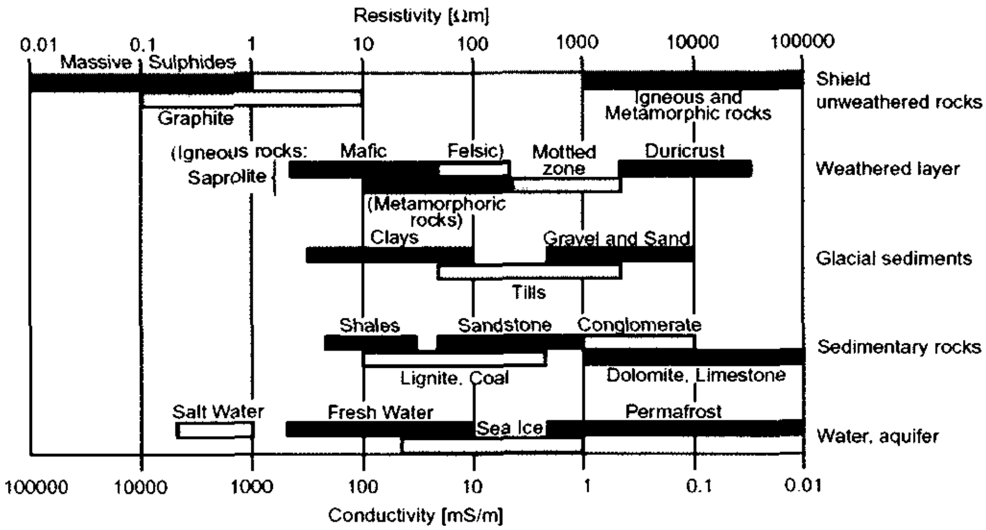


Figure 3: The resistivity (reciprocal of electrical conductivity) range of some geological materials.

Figure 3 provides a guide for the interpretation of electromagnetic data. Emphasis should be placed on the relative resistivity values of the various rocks rather than the absolute values, which do not necessarily reflect those values measured by surface methods. Massive sulphides have significantly lower resistivities than typical igneous host rocks, hence TEM methods are often capable of detecting massive sulphide ore bodies.

2.2 Horizontal-Loop Fixed-Frequency Electromagnetics (HLEM)

The horizontal loop electromagnetic method (HLEM) is a frequency-domain technique that uses portable transmitter and receiver coils to prospect for electically conductive ore bodies. By forcing electrical current through a transmitter coil at a known frequency, a primary electromagnetic field is induced at the surface. This EM field induces the flow of electrical current, at the same frequency, in the subsurface. The induced current in turn induces a secondary electromagnetic field, also at the same frequency, that can be measured at the surface. This secondary field can be used to infer the electrical characteristics of the subsurface. Since decreasing the frequency of the primary field increases the penetration depth of the induced current, using a suite of frequencies allows a variety of depths to be investigated.

The total field measured at the surface by the receiver is the sum of the primary and secondary fields. The measured phase lag, φ, at the receiver arises from the superposition of these two currents in one coil (Figure 4). The phase of current in the receiver coil is found by considering the currents induced by the primary and secondary fields as vectors on a plane whose x-axis represents a current in-phase with the primary, the y-axis being out-of-phase. In field surveys, the transmitter and receiver are linked via a cable so that the phase and amplitude of the primary field is known precisely. Referring to Figure 4, the secondary field **S** is determined by subtracting the primary field **P** from the total resultant field **R**. If the subsurface is electrically resistive, no significant in-phase secondary field is induced, and the out-of-phase field can be directly related to the resistivity of the subsurface. If, however, a large electrically conductive body exists in the subsurface, a large in-phase component in induced, and is opposite in polarity to the primary field. Figure 5 shows the typical in-phase and out-phase current response to typical near-surface, nearly vertical sulfide ore bodies.

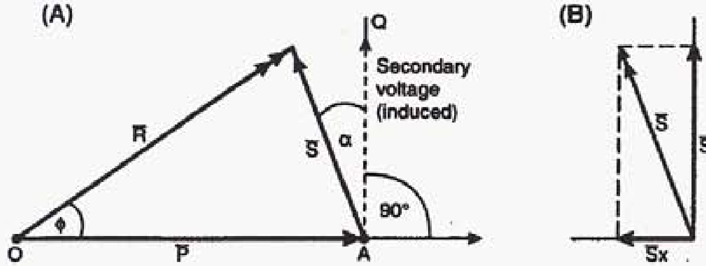


Figure 4: Illustration of the primary and secondary magnetic fields in the HLEM method

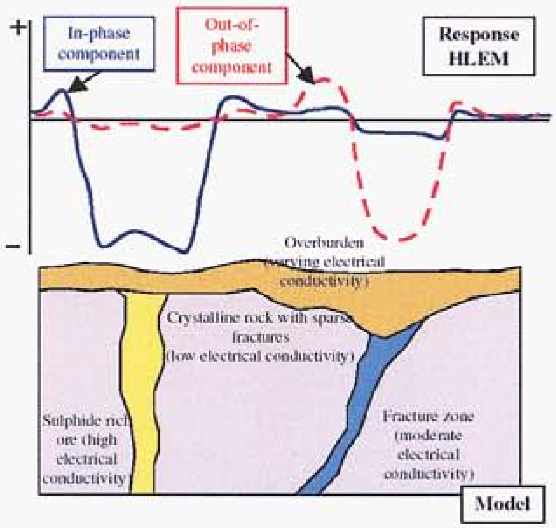


Figure 5: Typical response curves from an HLEM survey.

2.3 Electrical Resistivity / Induced Polarization

Resistivity methods infer the subsurface distribution of electrical resistivity, which is strongly related to the presence of metallic minerals. When a voltage is applied across a distance along the ground surface, electrical current will flow into the ground at one stake, and out of it at the second stake. The paths taken by the electrical current within the subsurface create voltage distributions at the surface that can be used to infer subsurface structure.

Briefly, the voltage gradient at the surface reflects the subsurface resistivity distribution. For a given current flow through a portion of ground, the voltage gradient at the surface will be directly related to the resistivity. High resistivities, which may represent barren host rock, or clay-free overburden, will be reflected in higher voltage gradients. Very low resistivities, which may represent the presence of metallic minerals, conductive pore fluids, clays, shales, or graphites, will result in low voltage gradients at the surface.

The induced polarization (IP) method images disseminated metallic minerals in the subsurface by exploiting the combination of two mechanisms of electrical current flow in the subsurface: electronic or electrolytic flow (conduction). Electronic conduction is the mechanism found in common metal wires: the electrical current and energy are carried by free electrons moving through a metallic material. A metallic medium is required for this type of conduction, since only metals have loosely held electrons that can easily be passed between neighbouring molecules. Minerals such as metallic sulphides support electronic conduction. Electrolytic conduction refers to current that flows as charged ions in a liquid. This is the form of conduction that exists inside a lead-acid battery. It is also the most common form of electrical conduction in the subsurface, since groundwater is usually far more capable of supporting electrolytic flow than earth materials are capable of supporting electronic flow.

The IP method exploits the fact that in areas where dispersed metallic minerals exist within a water-bearing host rock, the form of electrical conduction in the subsurface changes repeatedly between electrolytic and electronic. In the barren parts of the rock, conduction only occurs through the movement of charged ions in the groundwater. However, in areas where metallic minerals (such as metallic sulphides) occur, electrical current can flow via free electrons in the metallic mineral grains. At a boundary between a sulphide grain and the pore fluid, the current mechanism must change between electronic and electrolytic conduction. Therefore at the surface of a sulphide grain, a charge distribution builds: free electrons (negative charges) gather along the mineral edge, within the mineral, while positively charged ions in the pore fluid gather along the mineral edge, within the pore fluid. This leads to a large separation of charges – and a corresponding voltage – being created across the mineral grain. The mineral grain has therefore become electrically polarized, and this *induced polarization* is reflected in the voltages measured along the ground surface.

It takes a small but finite and measureable time to create the accumulations of charged particles in a region of disseminated sulphides. It also takes a small amount of time for the charge accumulations to dissipate once the driving current at the surface is turned off. If no metallic minerals exist in the subsurface in the region of induced current flow, the voltages measured at the surface will immediately return to zero as soon as the driving voltage and current are turned off. However, if charges have accumulated in the subsurface as a result of induced polarization, then voltages will be detected at the surface even after the driving voltage and current are turned off, because the accumulated charges require a small amount of time to dissipate.

(Clay minerals in the subsurface can also create IP responses, since these minerals typically support charges at their surfaces. These charge distributions can be displaced by a driving current, and require a finite time to return to normal after the driving current is turned off. The effect of clays is usually less than that of metallic minerals, however large polarizations can be created by some shales, graphites and argillites.)

3.0 FIELD OPERATIONS

3.1 TEM

The equipment comprised a Geonics Protem 57 Transmitter and a Protem 57D receiver. The equipment operates at repetition rates of 30, 7.5, and 3 Hz, with time gates centred at times ranging from 6.8 to 6978 ms. The receiver is a three-component coil with an effective area of 100 m^2. A Honda 1.5 kW generator was used as the power source.

The grid used for the work was provided by Imperial Metals. Accurate location information for the stations was not available at the time of the survey. However, the TEM profiling method is reasonably insensitive to location errors and small loop-size errors.

The original transmitter loop was 100 m by 200 m, and was oriented with its long dimension perpendicular to the lines. After conducting field tests, it was determined that the loop was too small, as the recorded data were too noisy to be useable. The loop was therefore changed to a 150 m by 300 m loop, with its northern edge 50 m north of Line A, and its southern edge at Line F. Its western and eastern edges were at stations 8600 and 8750 respectively.

The transmitter and receiver clocks were synchronized each morning prior to beginning the survey. The current flowing through the 150 m by 300 m loop was approximately 15 amperes. The receiver was then disconnected from the transmitter and moved along each line. At each station, 10 readings were averaged, at three gain settings.

TEM data were acquired from December 10 to 15, 2003, along portions of lines B, C, and D. This obtained responses both on and off the ore body. Based on outcrop and drill results, the ore body is roughly oriented NW-SE and dips NE at approximately 80°. Results could not be obtained between stations 9025 and 9075, on Line D, because of the presence of heavy equipment in the area that precluded the recording of useful data.

3.2 HLEM

Data were collected from January 14 to 17, across the strike of the ore body along lines D, E, and F using an Apex Parametrics Max-Min I HLEM instrument. A transmitter-receiver separation of 50 meters was applied to all lines, and a separation of 25 meters was also tested for line E. In-phase and out-of-phase data were obtained at 110, 220, 440, 880, 1760 and 3520 Hz. In-phase and out-of-phase anomalies were recorded with 50-m and 25-m coil separations and multiple frequencies across the strike of the buried ore body. Data were recorded at 74 locations, spaced 25 m, 12.5 m and 6.25 m apart along the survey lines, and were interpreted qualitatively.

3.3 Resistivity / IP

Any IP or resistivity survey requires the use of two current and two potential electrodes. This survey was carried out using a pole-dipole array, which uses two potential electrodes separated a distance a along the line; one current electrode separated a distance na from the nearest potential electrode, where n varied from 1 to 6; and one current electrode placed at a very great distance from the survey line, so that its location has no effect on the results. For this survey, a was set at

50 m (aside form three test lines, on which *a* was set at 25 m). Data were collected between January 17 to March 13, 2004.

The transmitter used to drive current through the current electrodes was a Phoenix IPT-1. It was powered by a 6.5-hp gasoline-powered electrical generator. The output current varied between 0.2 to 2.0 A when the current was on. The current waveform repeated an eight-second cycle: 2 s on, with positive polarity, 2 s off, 2 s on with negative polarity, and 2 s off.

The receiver used to measure the voltages across the potential electrodes was an Iris ELREC-6. This unit sampled the voltage in ten windows, beginning 80 ms after current turn-off, with the following integration times: 20, 20, 40, 60, 100, 140, 180, 260, 380, and 560 ms.

Additional information for the transmitter and receiver are contained in Appendix B.

Electrical contact was made with the ground using stainless steel electrodes. These electrodes were used instead of copper-sulphate-filled porous pots, since they lead to faster, less expensive surveys, and since it has been shown in other surveys that they do not significantly affect the data quality.

For each receiver set-up, 16-gauge wires were attached between the receiver and seven electrodes (for six voltage dipole readings). The current electrode was a stainless steel electrode, positioned 50 m from the first dipole, inserted approximately 30 cm into the ground. This electrode was connected to the transmitter, which remained stationary for an entire line. The second current electrode was located a minimum of 500 m from the line. The receiver records the primary voltages (voltage during current 'on-time'), secondary voltages (during current 'off-time'), spontaneous potential voltages (natural voltages present between the electrodes prior to survey) from the six receiver dipoles, integrated normalized secondary voltages – the chargeabilities, the transmitter current, the number of readings averaged, the standard deviations of the readings, and the recording time. The integrated chargeability is the sum of each normalized secondary voltage multiplied by its sample interval, then re-normalized to one-second integration by dividing by the total sample interval.

4.0 DATA PROCESSING

The electromagnetic data were not heavily processed, and the plotting procedures are discussed in Section 5.0.

The resistivity / IP data were processed by Discovery Geophysics using the IP-inversion software DCIP2D developed at the University of British Columbia Geophysical Inversion Facility. The inversion algorithm is based on the method developed by Oldenburg and Li (1994). The routine attempts to produce images that accurately reflect true subsurface variations, both in terms of true resistivity and chargeability, as well as in terms of subsurface geometry. It is a two-dimensional algorithm that divides the earth into a rectilinear mesh of two-dimensional prisms (the prisms have an infinite third dimension, perpendicular to the plane of the section), each of which is associated with a resistivity and chargeability.

The size of the earth model (the set of prisms) is generally sufficiently large that the problem of determining the true subsurface resistivity and chargeability distributions is undetermined. Therefore the algorithm imposes the constraint that the model must be the simplest one that fits the observed data. There are a number of definitions of what constitutes 'simple'. The algorithm searches for the most smoothly varying model that fits the observed data to within a specified tolerance.

The inversion process described above is generally a significant improvement over the traditional pseudo-section method, which simply plots apparent resistivity and chargeability at a point midway between the near current electrode and the near potential electrode, at a depth equal to half the electrode separation. However, for completeness, the results have also been plotted as pseudo-sections.

5.0 RESULTS

5.1 TEM

Figures 6 through 11 show the results from the transient survey. The data have been plotted as induced receiver voltages versus distance along lines B, C, and D, for the 30 time gates recorded. Results for each line are split into two plots: one for the first 10 time gates, 6.8 ms to 61.13 ms; and one for the remaining 20 time gates, from 88.13 ms to 6978 ms.

5.2 HLEM

The results from the horizontal loop survey are shown in Figures 12 to 15. For each line, the data are plotted as a percentage of the primary field strength versus station number for in-phase and out-of-phase responses – one curve for each frequency. The calculated electrical conductivities – also plotted for each frequency – are calculated from the out-of-phase responses.

A few gaps exist in the coverage. These were caused either by the presence of heavy equipment that made the readings meaningless, or by the presence of heavy traffic. The traffic became hazardous if it crossed the cable connecting the transmitter and receiver (and therefore the operators) together: therefore these stations were dropped from the survey.

5.3 Resistivity / IP

The resistivity and chargeability results were plotted by Discovery Geophysics as a series of cross-sections, both as pseudo-sections and inversion sections, in Figures 16 to 50 (Sections 4650 to 6200 N, plus lines D, E, and F). The locations of the lines are shown in Figure 1c.

The test lines are shown in Figures 48 to 50, at the back of Appendix A. Lines D and E both show very strong chargeability anomalies centred at approximately station 9050. Line F shows a similar very strong chargeability anomaly at station 9100. These results correlated very well with the known ore body. They were used as the motivation for the larger IP survey.

The inversion sections show a wide variety of styles of chargeability anomalies. These range from small discrete anomalies at (or very near) the surface (see, for example, both anomalous highs and lows in sections 4750 N and 4850 N); to broad, low-amplitude chargeability highs (e.g., centred at 2500 E, on sections 5600 N and 5650 N); to narrow, intense chargeability highs (e.g., between 2650 E and 2900 E, in sections 5440 N and 5450 N).

The chargeability anomalies in the central portions of the sections (between approximately 2500 E and 3000 E) appear to show a reasonably consistent trend between sections 5000 N and 5650 N. The major anomaly appears to reach the surface on sections 5450 N and 5500 N, at 2700 to 2750 E. It then plunges to the north, disappearing off the bottom of sections 5650 and 5700. That same major anomaly also plunges to the south, and decreases in amplitude, disappearing between sections 5000 N and 4950 N at 2900 E.

Fewer anomalies appear in the resistivity inversion sections. Small discrete anomalies (highs and lows) appear at the surface, as in the chargeability sections. One large continuous conductor appears to exist at 2100 E, on section 5750 N. It continues northeastward, last appearing at 2300 E on section 6200 N. The resistivity highs in the eastern portions of the sections that extend from surface to the maximum depth are related to Polley Lake sediments and should be disregarded.

6.0 DISCUSSION

6.1 TEM

For a vertical conductor, TEM profiles across the conductor would be expected to produce a peak in the X-component (perpendicular to strike) profile, and a cross-over in the Z-component (vertical) profile. Weak indications of conductors are visible on Lines B, C, and D. For example, on Line B (Figure 7), a small peak in the X-component and a cross-over in the Z-component appear in the middle-time gates at stations 9025 to 9050. Similar features are visible on Line C (Figure 9) at station 9050, and on Line D (Figure 11) between stations 9075 and 9125.

6.2 HLEM

The survey detected out-of-phase responses indicative of vertical conductive bodies. On Line D, (Figure 12), a clear anomaly is located at station 9050, which correlates well with the location of the ore body. A similar anomaly exists on Line E, in both 50-m coil-separation data (Figure 13) and 25-m separation data (Figure 14), at station 9060.

The out-of-phase response is normally used only to infer ground conductivities in reasonably resistive ground, and is not normally used to detect conductive bodies (see, for example, Figure 5). In this survey, no obvious in-phase conductive responses were detected. This may reflect possible coil-separation errors that could have occurred in the field as a result of conducting the test survey without a prior location survey of the grid stations. The in-phase response of an HLEM survey is sensitive to coil-separation errors of a few metres or less, whereas the out-of-phase response is less sensitive to these errors. Without a prior survey, coil separation is difficult to maintain accurately over a 25- or 50-m distance on a non-planar hillside.

6.3 Resistivity / IP

The most intense chargeability anomalies imaged in the survey, in sections 5400 N and 5450 N, correlate with the known ore body. This suggests that the IP method may be useful in exploring for other ore bodies.

It is important to note that the inversion results represent one set of earth models that fit the observed data, and that many other models exist that would also fit the data. Imperial Metals has noted that the strong anomalies on sections 5400 N and 5450 N only correlate with the top of the known ore body: the deeper (known) portions of the ore body have not been imaged. It is therefore possible that alternative processing methods may better image the known ore body, and by corollary, better image undiscovered ore bodies.

A comparison of the background chargeabilities in each section shows that in sections 5400 N and 5450, the background chargeabilities are significantly lower than in other sections. This is likely not representative of reality. It may therefore make sense to reprocess the data using a different criterion for the type of model desired. For instance, since the drill results are known, it would be sensible to search for earth models that fit the data, but that also are 'closest' to the known geology. (This type of model is often referred to as a 'nearest' or 'smallest deviatoric' model.)

In general, the anomalous chargeability highs in the sections correspond to anomalous resistivity highs. This can be indicative of disseminated sulphides: although the metallic minerals themselves are conductive, they do not constitute a connected path for electrical conduction. (Note that non-economic sulphides, such as pyrite, will produce results identical to those caused by economic minerals such as chalcopyrite.)

The major anomalies on sections 5400 N and 5450 N, however, correspond with some weak resistivity lows. Although the lows are not well defined, their presence suggests that the electrical resistivity of the ore body should be tested, to determine whether any type of electromagnetic methods could be used to detect high-grade ore zones. It would therefore be worthwhile making laboratory measurements of the electrical resistivity of portions of the drill core.

Narrow, near-surface chargeability and resistivity highs and lows such as those noted on sections 4750 N and 4850 N should be viewed with caution. These may represent either electrode polarization effects caused by the use of steel electrodes, or regions of poor contact resistance. Further, geophysical inversion algorithms can have the tendency to force model fits by creating isolated surface anomalies at the measurement points.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The TEM profiling survey presented a weak indication of the ore body in the Northeast Zone. The HLEM survey detected the ore body in the out-of-phase response, which typically is not used for detecting massive conductors. This leads to two conclusions:

- Coil-separation errors may have masked an in-phase response. As a result of this possibility, all HLEM grid stations should be surveyed prior to conducting the geophysical survey. This would allow in-field corrections to coil separations on steep slopes that would increase data quality.
- The ore body may not be electrically connected over sufficient distances to induce an in-phase response, but it is sufficiently connected to induce a recognizable out-of-phase response. If this is the case, then it may be difficult to differentiate the ore body from a weak vertical conductor such as a clay-lined fault. It should, however, detect similar ore bodies.

Therefore, although only weak indicators of a vertical conductor were detected in this survey, HLEM methods should not be ruled out as potentially useful exploration tools, particularly if careful attention is paid to grid preparation.

The induced polarization survey mapped large chargeability anomalies that correspond with the known ore body in the Northeast Zone of the Mount Polley Mine site. This suggests that IP can be a useful exploration tool in the future.

The IP data should be reprocessed to incorporate the known drill results. The inversion should then be constrained to fit the drill results, and only vary outside this region. It should also be carried out using real topographic variations rather than a flat surface, as topography affects electrical current-flow patterns.

An inspection of the results suggests that the ore body is not nearly two-dimensional. Therefore two-dimensional IP methods may be better suited as reconnaissance methods useful for identifying high-potential areas, rather than as detailed ore-body-delineation methods. Should more detailed images be desired, three-dimensional processing (and possibly three-dimensional acquisition) of data may be required.

The low-resistivity anomaly noted above, in the west of sections 5750 N to 6200 N warrants further investigation.

Portions of the drill core from the ore body should be tested in a laboratory to determine the limits of the electrical resistivity and the chargeability of the ore. This would improve interpretation of the results, as well as guide exploration efforts in the future.

8.0 REFERENCE

Oldenburg, D.W. and Li, Y.: Inversion of induced polarization data, Geophysics, vol.59, no.9, pp.1327-1341, 1994.

9.0 Statement of Qualifications

I, David B. Butler, of the city of Vancouver, in the province of British Columbia, hereby certify as follows:

1. I am a Professional Geoscientist employed by Associated Mining Consultants Ltd., with an office at Suite 300, 4940 Canada Way, Burnaby, B. C., V5G 4M5.
2. I hold the following university degrees: Bachelor of Applied Science, Geological Engineering (Geophysics Option), Queen's University, 1986; Master of Science, Geophysics, University of British Columbia, 1990; Doctor of Philosophy, Geophysics, University of British Columbia, 1995.
3. I am a registered professional geoscientist with The Association of Professional Engineers and Geoscientists of the Province of British Columbia (registration number 27,824).
4. I am an active member of the Society of Exploration Geophysicists.
5. I have practised my profession as a geophysicist (1986-1988), a research geoscientist (1988-1997), an assistant professor of geophysics (1997-1998), and a geophysical consultant (1988 - present).
6. I have no direct interest in Imperial Metals Corporation or the property described in this report, nor do I intend to have any direct interest.

Dated at Vancouver, in the Province of British Columbia, on the 25th of May, 2005.

David B. Butler

10.0 Statement of Costs

The work performed for this project was invoiced based on fixed costs for data acquisition, and fixed per-km costs for line cutting. The costs were as follows:

Line Cutting:

Line-kilometres cut:	51.55
Cost:	$40,140

Electromagnetic Data:

Line-kilometres of test data:	2.5
Cost:	$36,175

Induced Polarization Data:

Line-kilometres acquired:	51.3
Cost:	$108,460

APPENDIX A

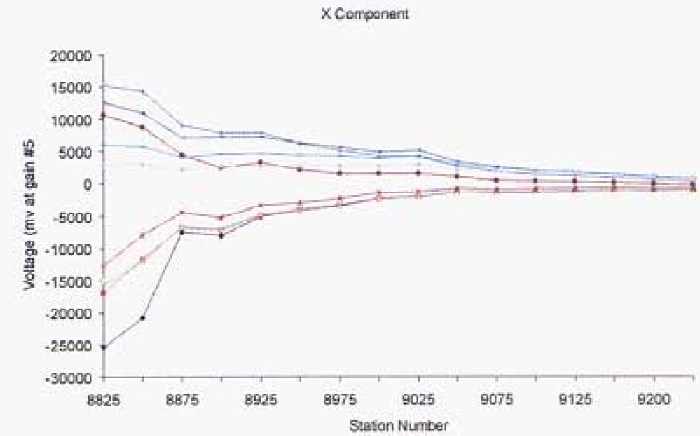
TEM AND HLEM SECTIONS,

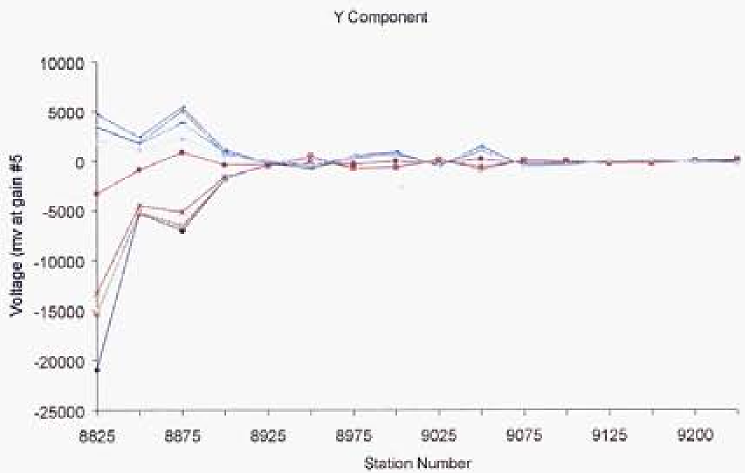
as well as

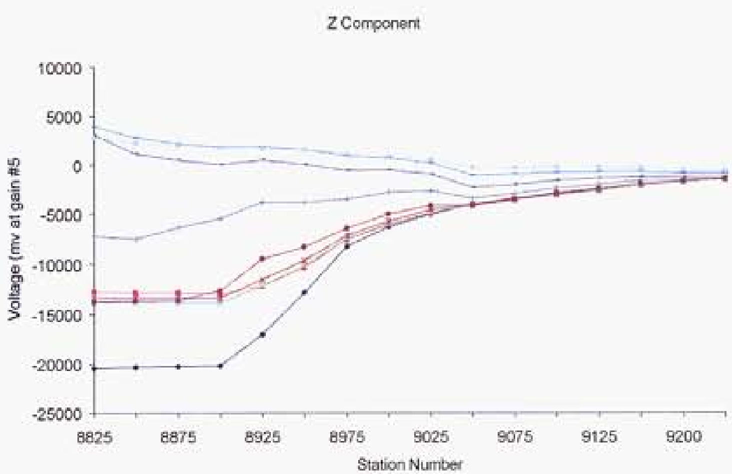
RESISTIVITY AND CHARGEABILITY

PSEUDO-SECTIONS and INVERSION SECTIONS

A2

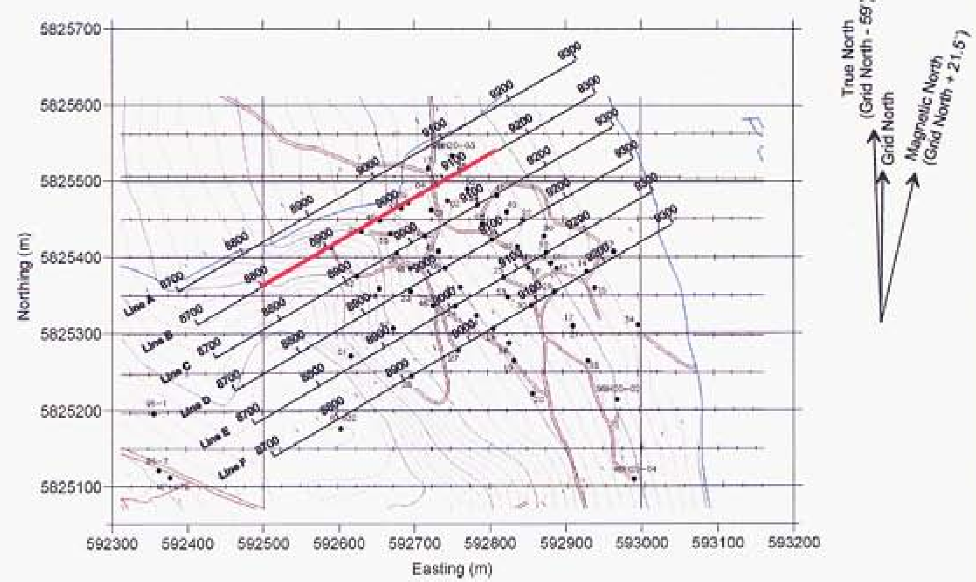






- Gate 1: 6.813
- Gate 2: 8.688
- Gate 3: 11.13
- Gate 4: 14.19
- Gate 5: 18.07
- Gate 6: 23.06
- Gtae 7: 29.44
- Gate 8: 37.56
- Gate 9: 47.94
- Gate 10: 61.13

ms



Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

Transient Electromagnetic Survey, Mount Polley Area

Fig. 6: Line B TEM response, Early Time

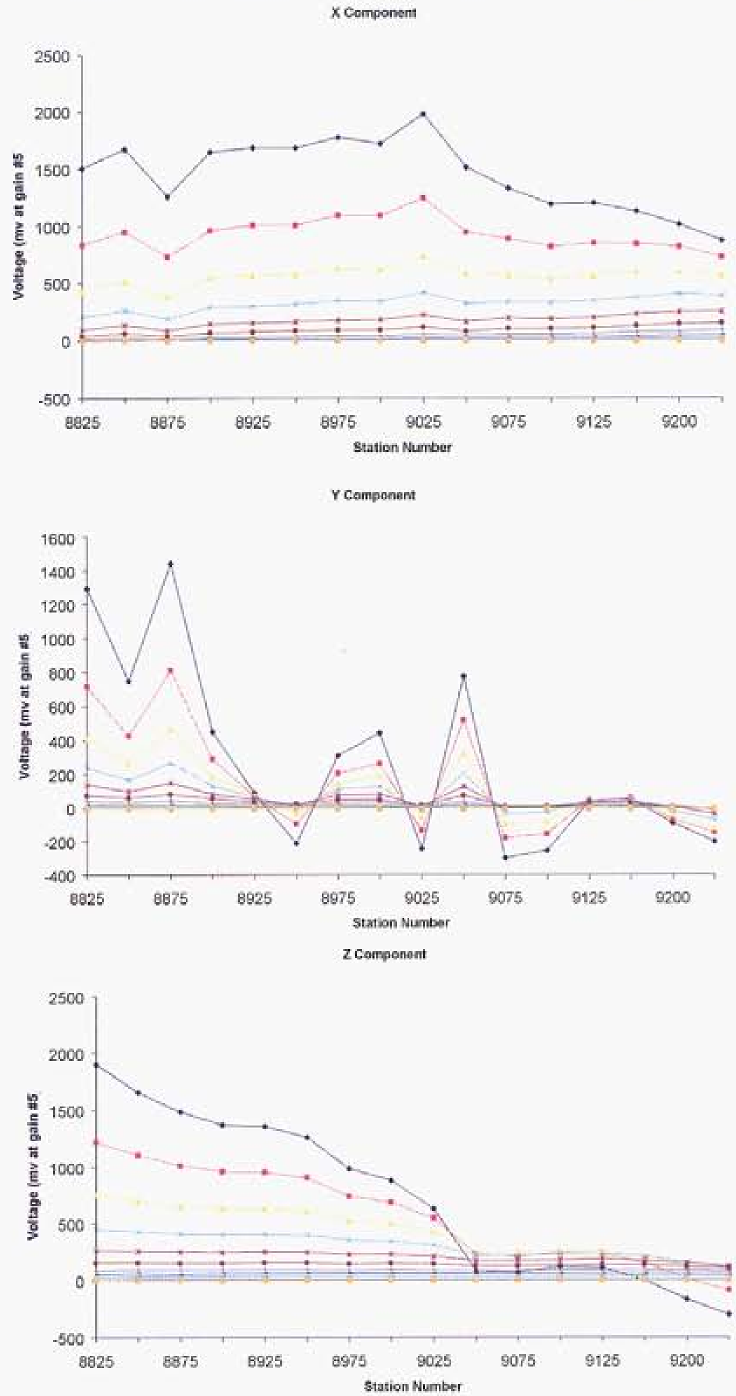
Project: PW08

Imperial Metals

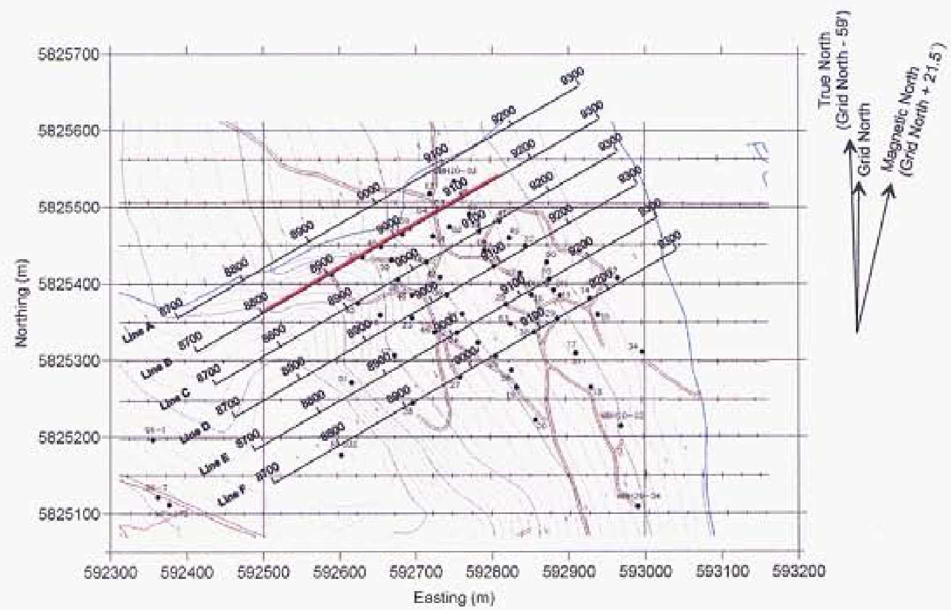
Mount Polley Property

IMC

Associated Mining Consultants Ltd.



A3



- Gate 1: 88.13
- Gate 2: 106.9
- Gate 3: 131.3
- Gate 4: 161.9
- Gate 5: 200.6
- Gate 6: 250.6
- Gtae 7: 314.4
- Gate 8: 395.6
- Gate 9: 499.4
- Gate 10: 631.3
- Gate 11: 799.4
- Gate 12: 1014
- Gate 13: 1287
- Gate 14: 1636
- Gate 15: 2081
- Gate 16: 2648
- Gate 17: 3373
- Gate 18: 4297
- Gate 19: 5475
- Gate 20: 6978

ms

Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

Transient Electromagnetic Survey, Mount Polley Area

Fig. 7: Line B TEM response, Middle to Late Time

Project: PW08

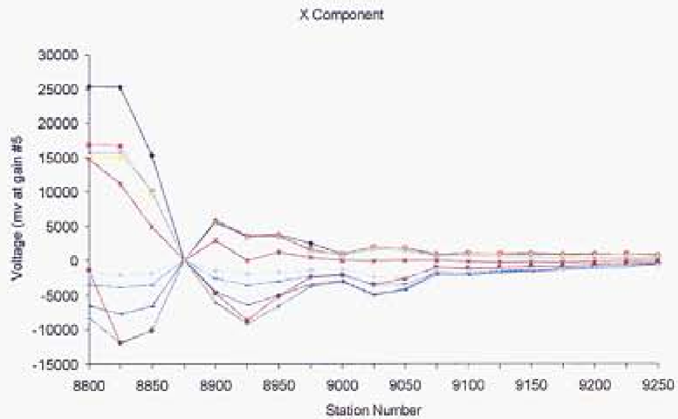
Imperial Metals

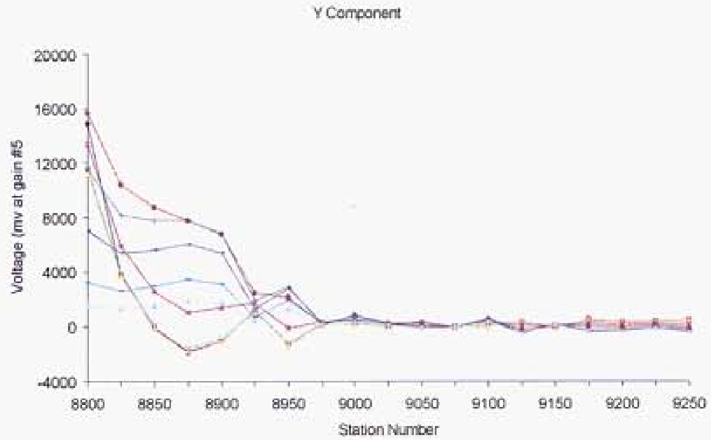
Mount Polley Property

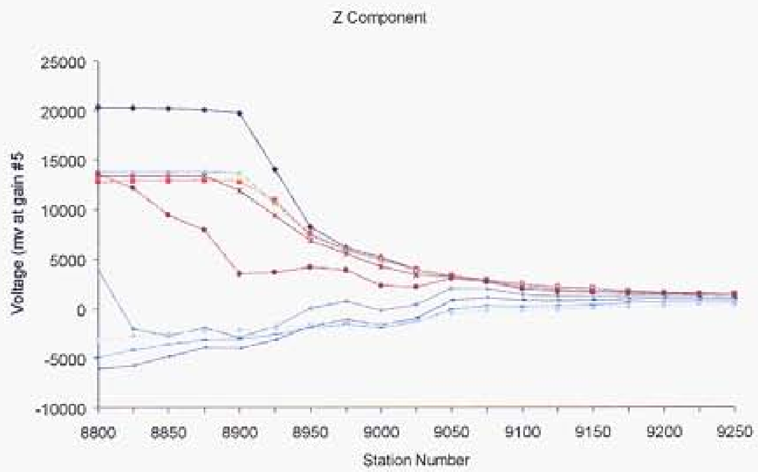
IMC

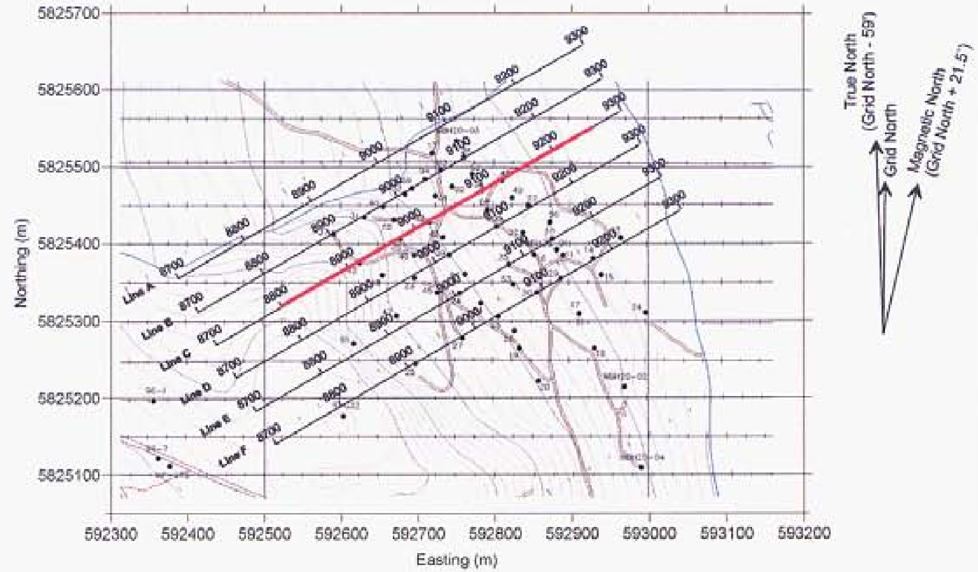
Associated Mining Consultants Ltd.

A4









Gate 1: 6.813
Gate 2: 8.688
Gate 3: 11.13
Gate 4: 14.19
Gate 5: 18.07
Gate 6: 23.06
Gtae 7: 29.44
Gate 8: 37.56
Gate 9: 47.94
Gate 10: 61.13

ms

Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

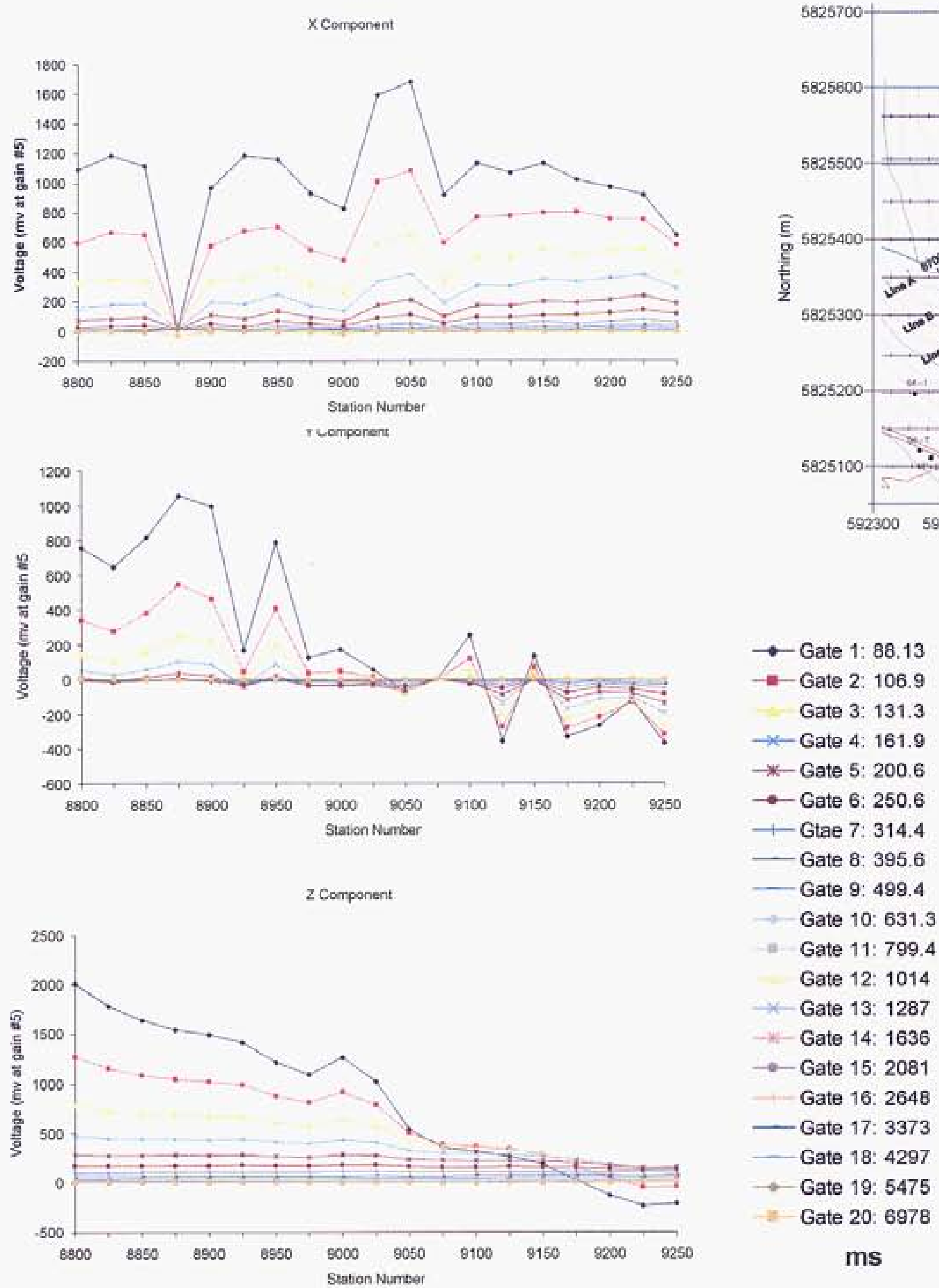
Transient Electromagnetic Survey, Mount Polley Area

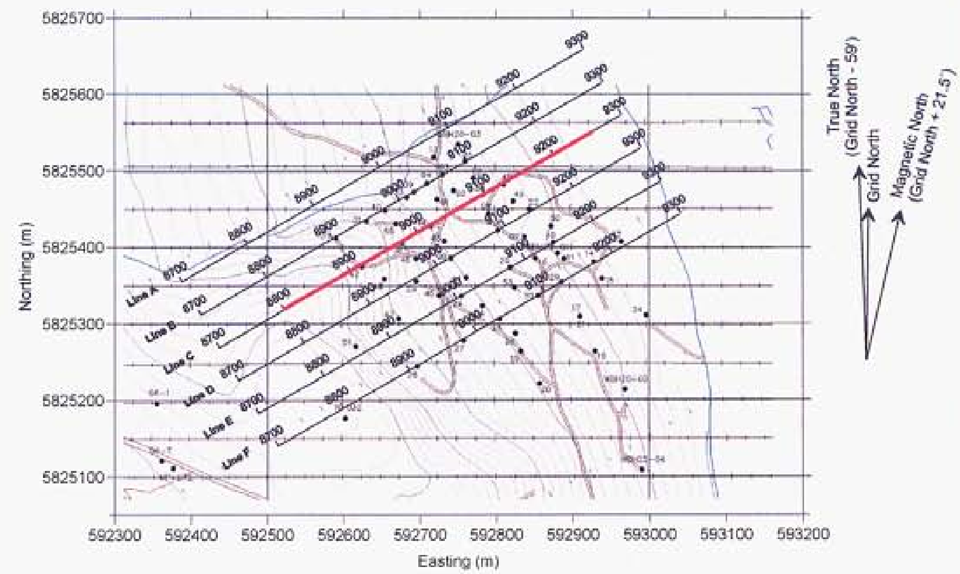
Fig. 8: Line C TEM response, Early Time

Project: PW08

Imperial Metals
Mount Polley Property

IMC
Associated Mining Consultants Ltd.





Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

Transient Electromagnetic Survey, Mount Polley Area

Fig. 9: Line C TEM response, Middle to Late Time

Project: PW08

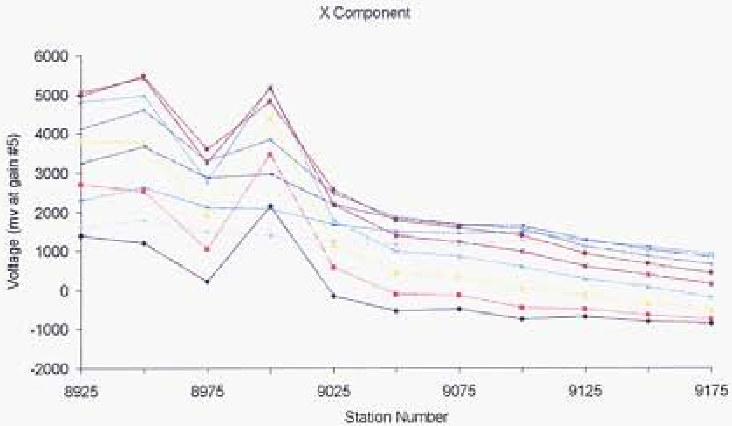
Imperial Metals

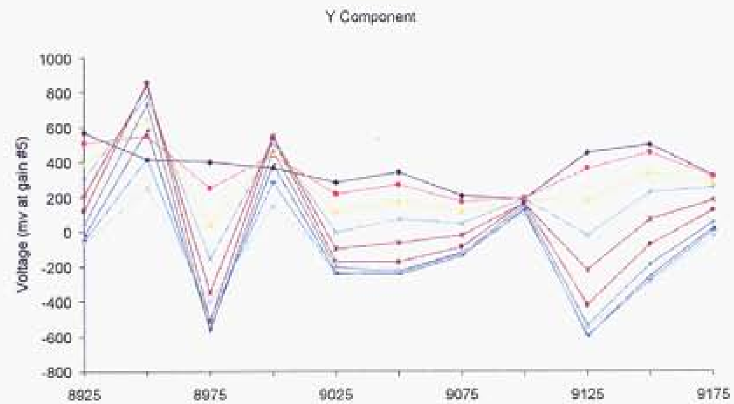
Mount Polley Property

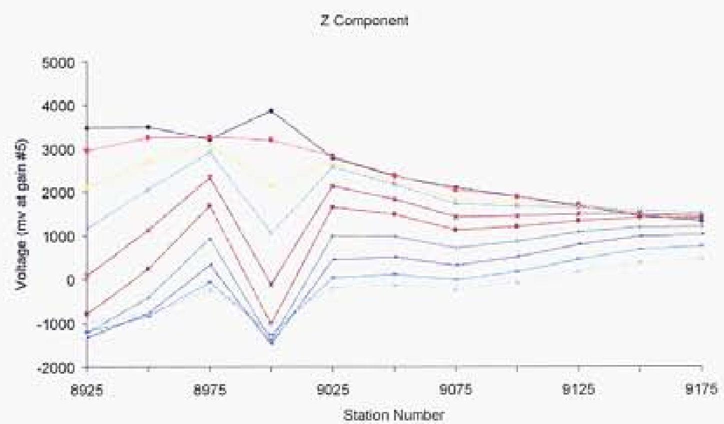
IMC

Associated Mining Consultants Ltd.

A6

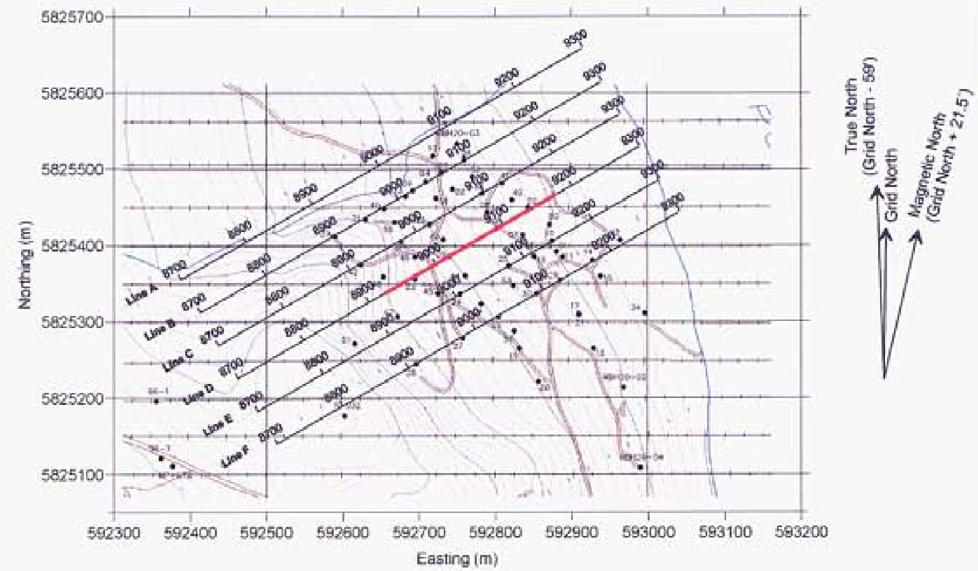






- Gate 1: 6.813
- Gate 2: 8.688
- Gate 3: 11.13
- Gate 4: 14.19
- Gate 5: 18.07
- Gate 6: 23.06
- Gtae 7: 29.44
- Gate 8: 37.56
- Gate 9: 47.94
- Gate 10: 61.13

ms



Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

Transient Electromagnetic Survey, Mount Polley Area

Fig. 10: Line D TEM response, Early Time

Project: PW08

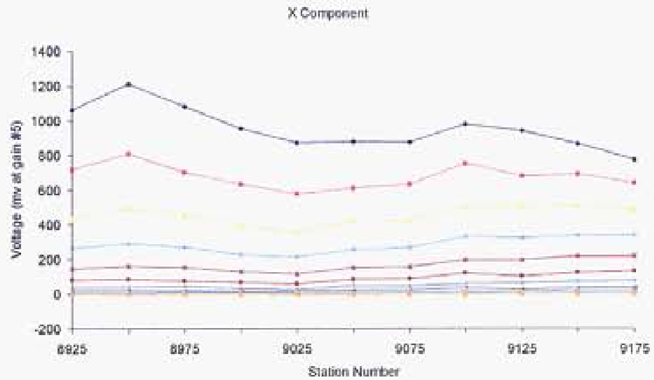
Imperial Metals

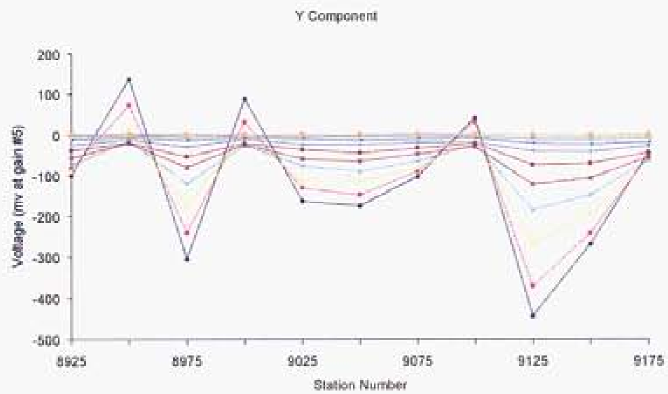
Mount Polley Property

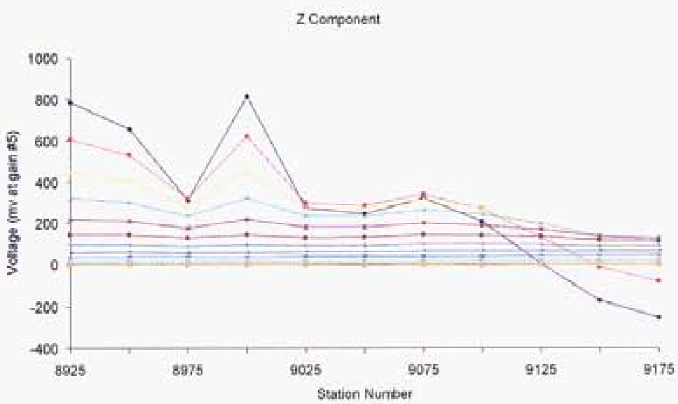
IMC

Associated Mining Consultants Ltd.

A7

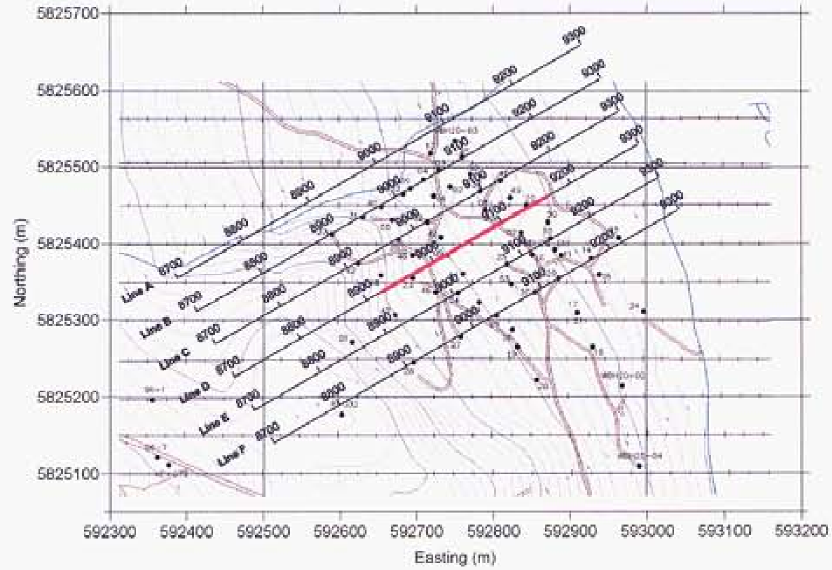


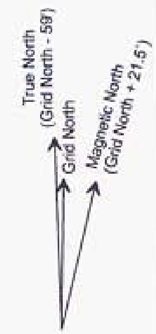




Gate 1: 88.13
Gate 2: 106.9
Gate 3: 131.3
Gate 4: 161.9
Gate 5: 200.6
Gate 6: 250.6
Gtae 7: 314.4
Gate 8: 395.6
Gate 9: 499.4
Gate 10: 631.3
Gate 11: 799.4
Gate 12: 1014
Gate 13: 1287
Gate 14: 1636
Gate 15: 2081
Gate 16: 2648
Gate 17: 3373
Gate 18: 4297
Gate 19: 5475
Gate 20: 6978

ms





Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

Transient Electromagnetic Survey, Mount Polley Area

Fig. 11: Line D TEM response, Middle to Late Time

Project: PW08

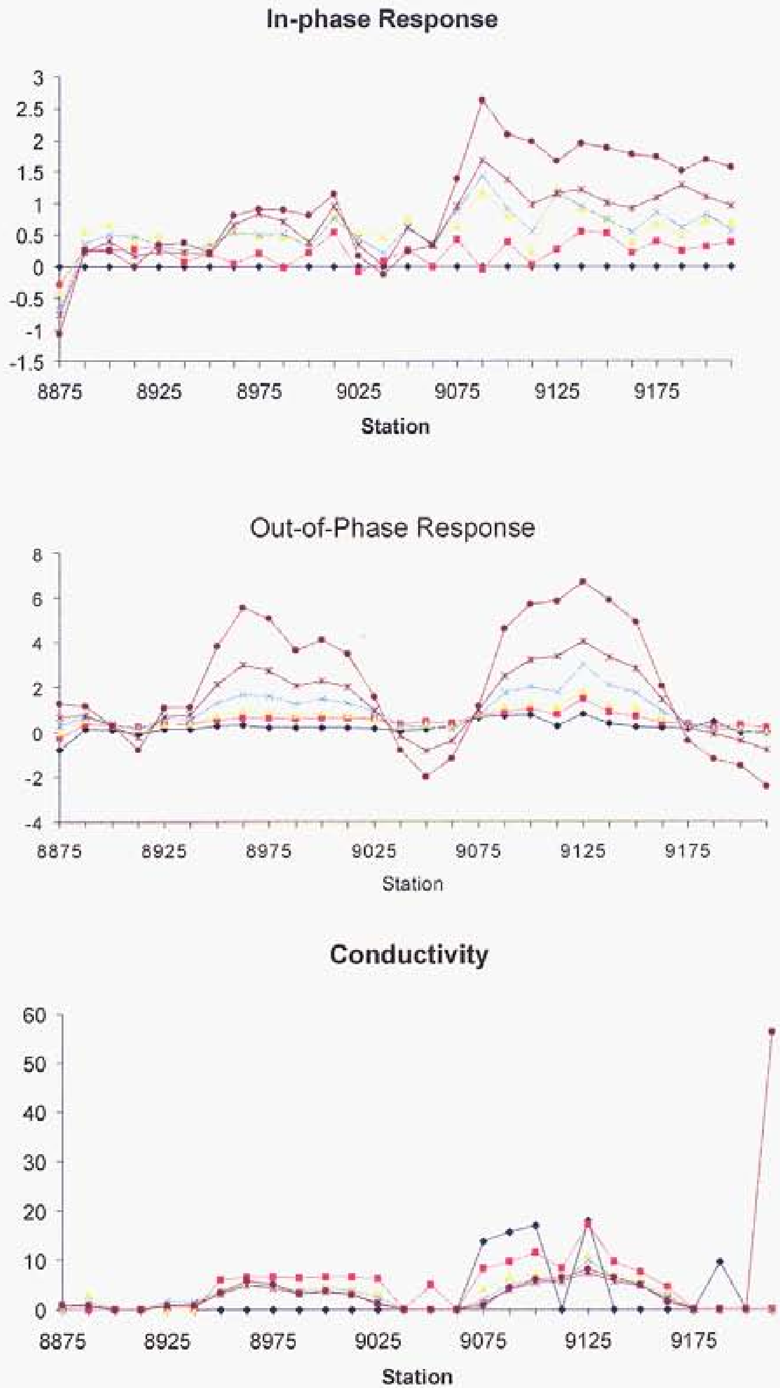
Imperial Metals

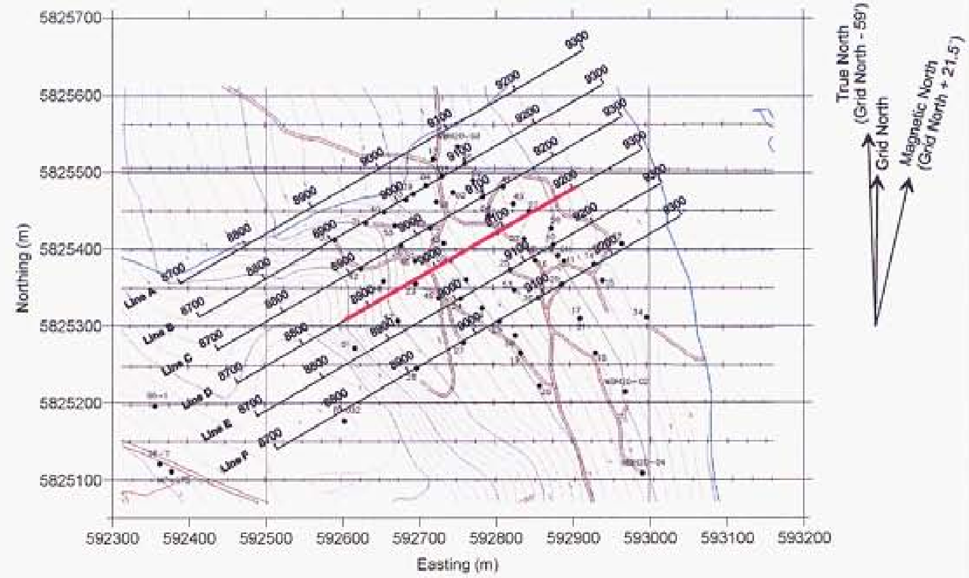
Mount Polley Property

IMC

Associated Mining Consultants Ltd.

A8





Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

Frequencies:

- 110 HZ
- 220 HZ
- 440 HZ
- 880 HZ
- 1760 HZ
- 3250 HZ

Max-Min Electromagnetic Survey, Mount Polley Area

Fig. 12: Line D Secondary EM Response, Coil Spacing: 50 M

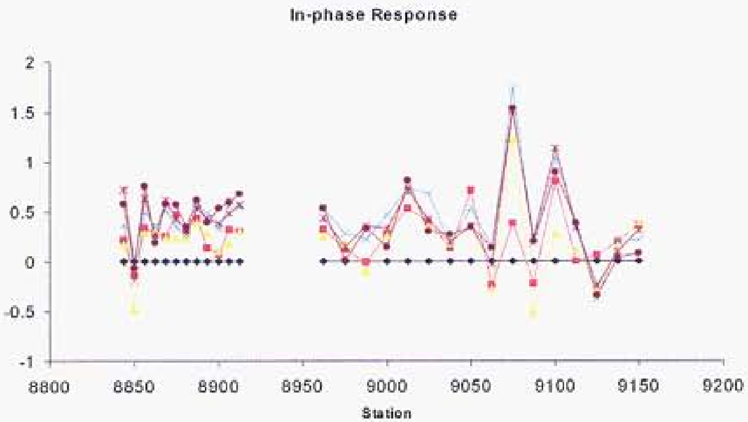
Project: PW09

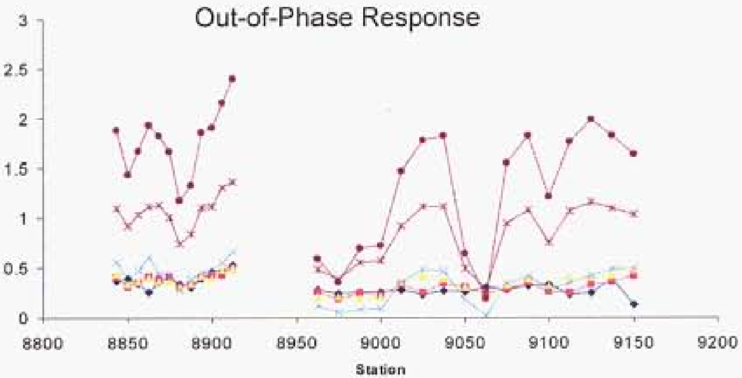
Imperial Metals

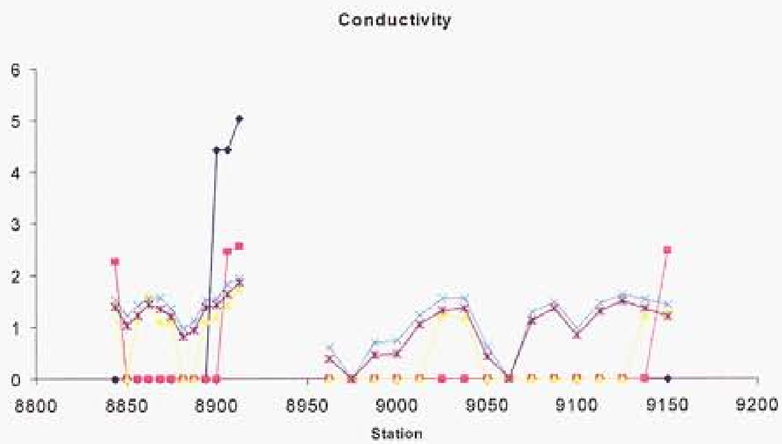
Mount Polley Property

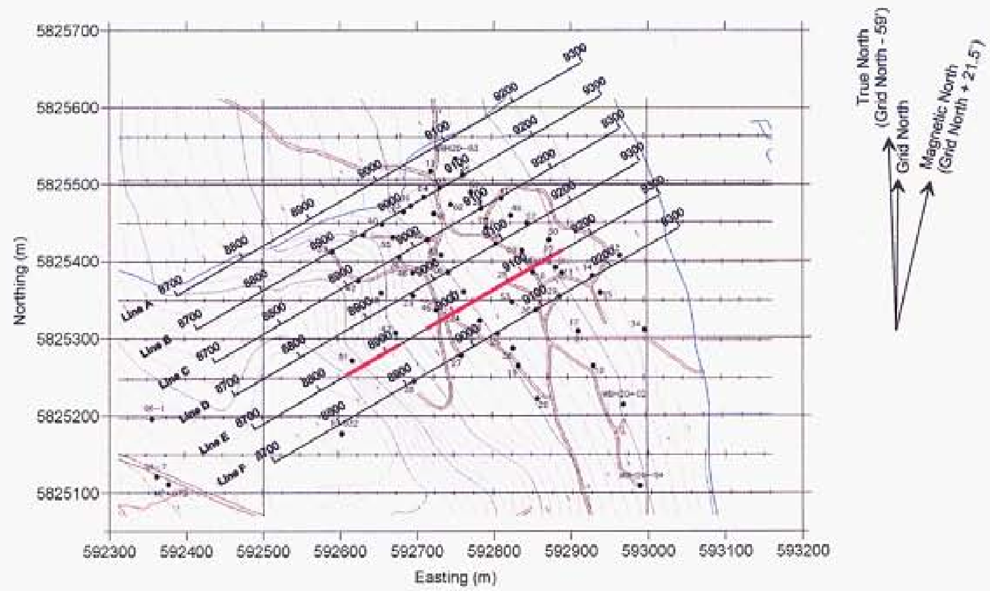
IMC

Associated Mining Consultants Ltd.









Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

Frequencies:

- 110 HZ
- 220 HZ
- 440 HZ
- 880 HZ
- 1760 HZ
- 3250 HZ

Max-Min Electromagnetic Survey, Mount Polley Area

Fig. 13: Line E Secondary EM Response, Coil Spacing: 50 M

Project: PW09

Imperial Metals
Mount Polley Property

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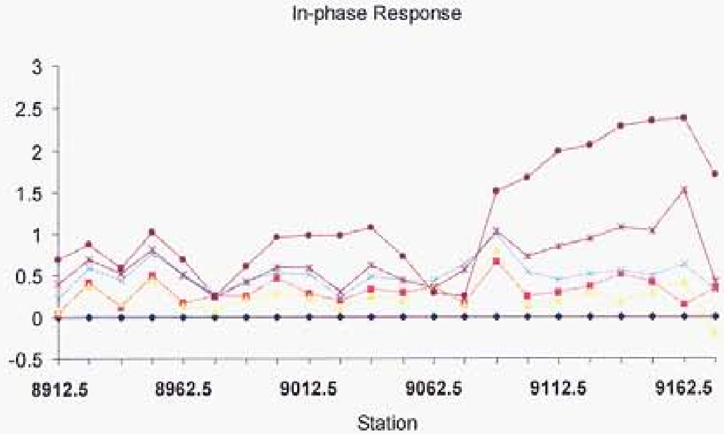
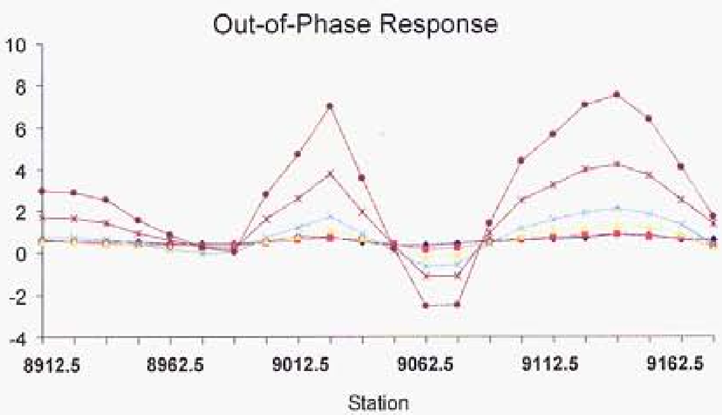
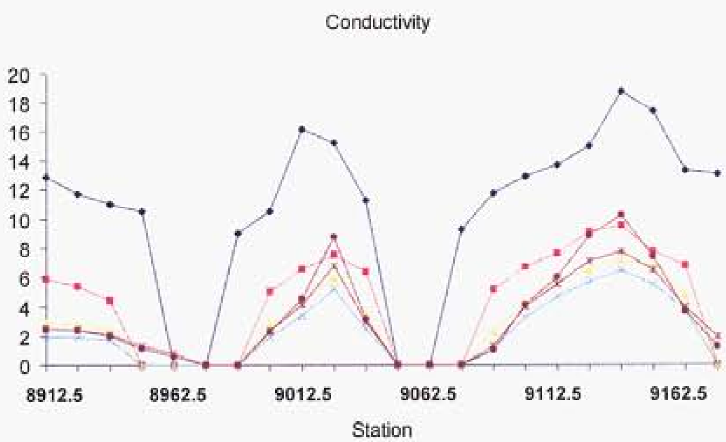
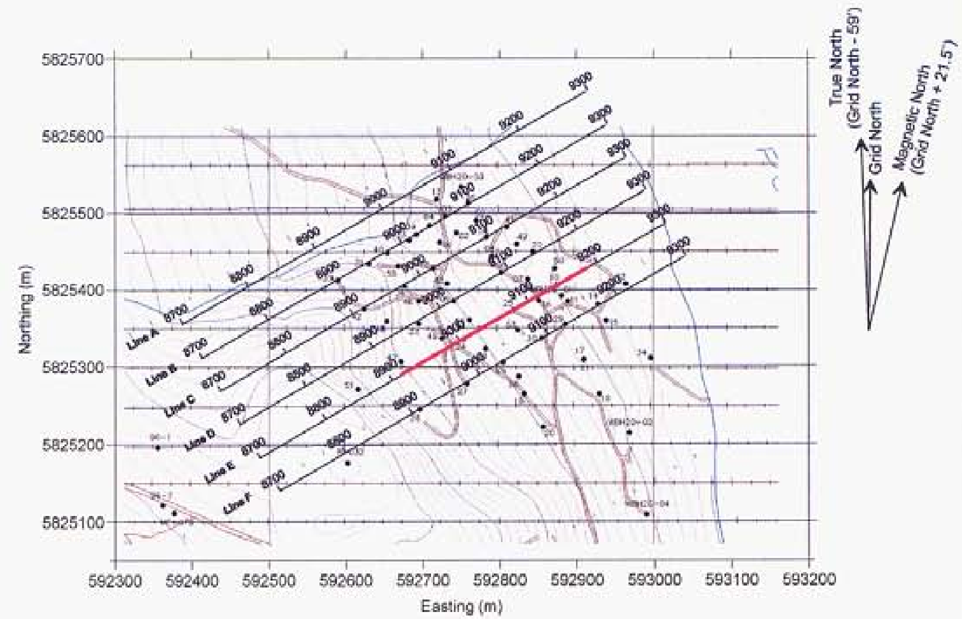
Associated Mining Consultants Ltd.

A10









Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

Frequencies:

- 110 HZ
- 220 HZ
- 440 HZ
- 880 HZ
- 1760 HZ
- 3250 HZ

Max-Min Electromagnetic Survey, Mount Polley Area

Fig. 14: Line E Secondary EM Response, Coil Spacing: 25 M

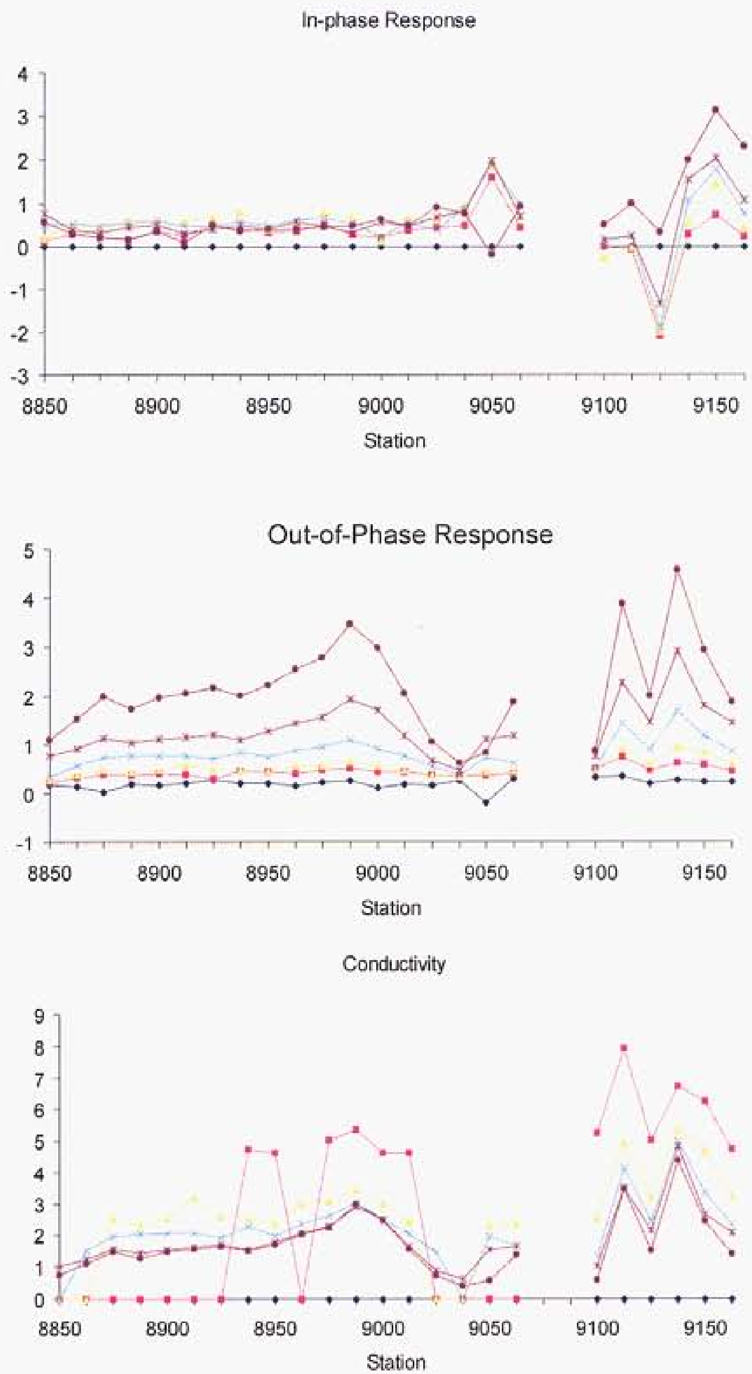
Project: PW09

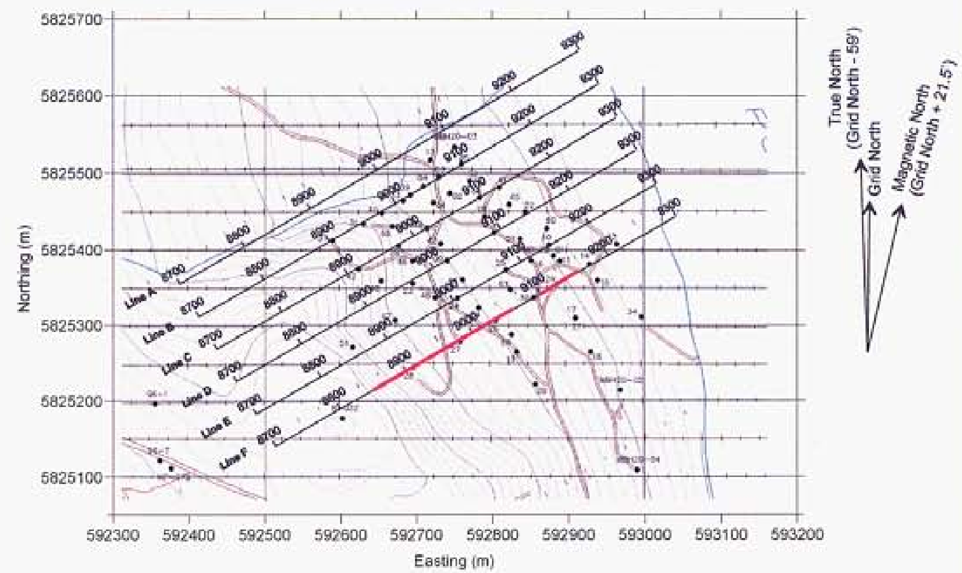
Imperial Metals

Mount Polley Property

IMC

Associated Mining Consultants Ltd.





Frequencies:

- 110 HZ
- 220 HZ
- 440 HZ
- 880 HZ
- 1760 HZ
- 3250 HZ

Map Coordinate System: NAD 1983, Zone 10

Scale = 1:10,000

0 100 200 300 400 500

metres

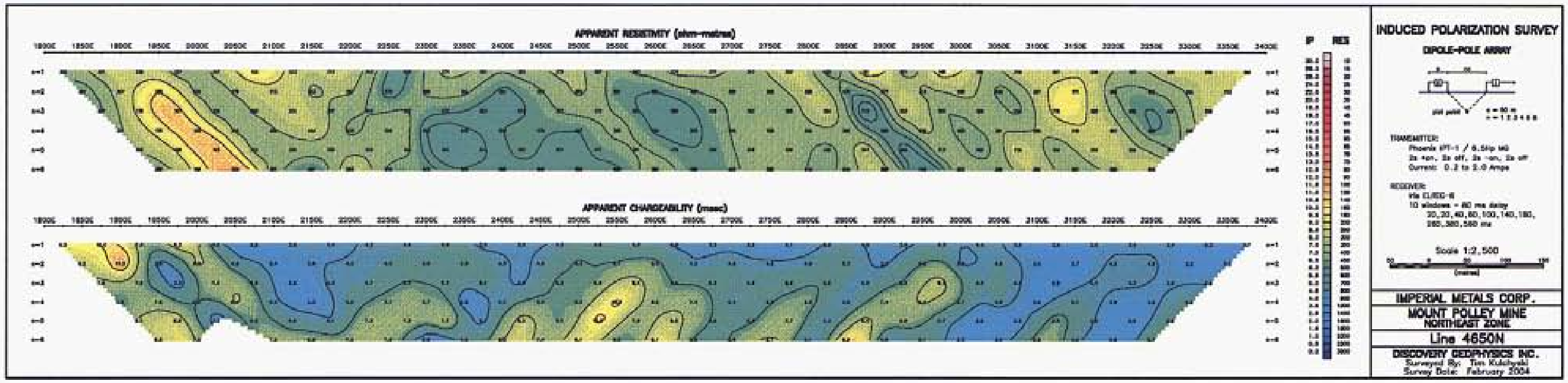
Max-Min Electromagnetic Survey, Mount Polley Area

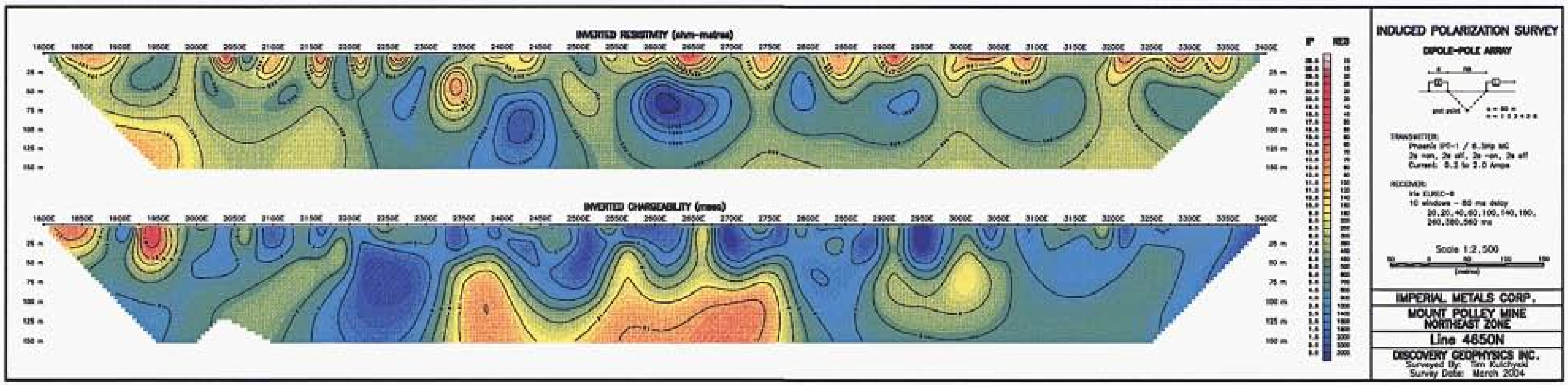
Fig. 15: Line F Secondary EM Response, Coil Spacing: 50 M

Project: PW09

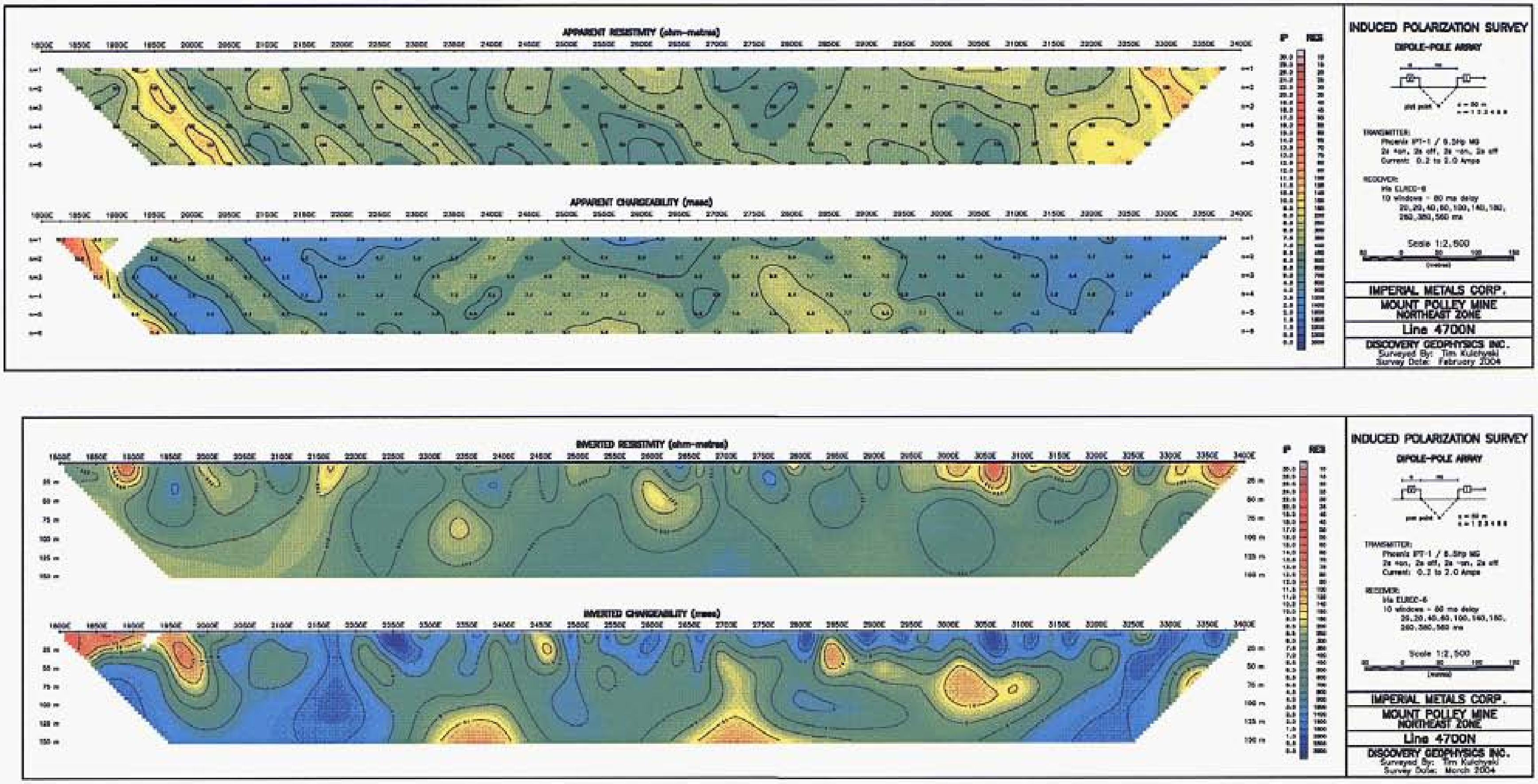
Imperial Metals
Mount Polley Property

IMC
Associated Mining Consultants Ltd.





Mount Polley Northeast Zone Induced Polarization Survey
Figure 16: Line 4650, Pseudo-sections and Inversion Sections
IMC Associated Mining Consultants Ltd.

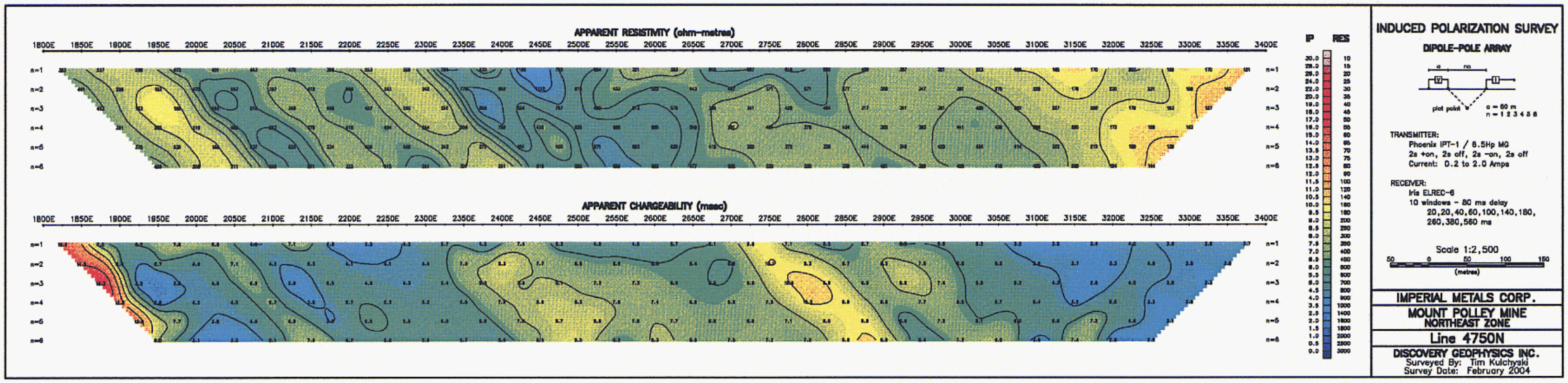


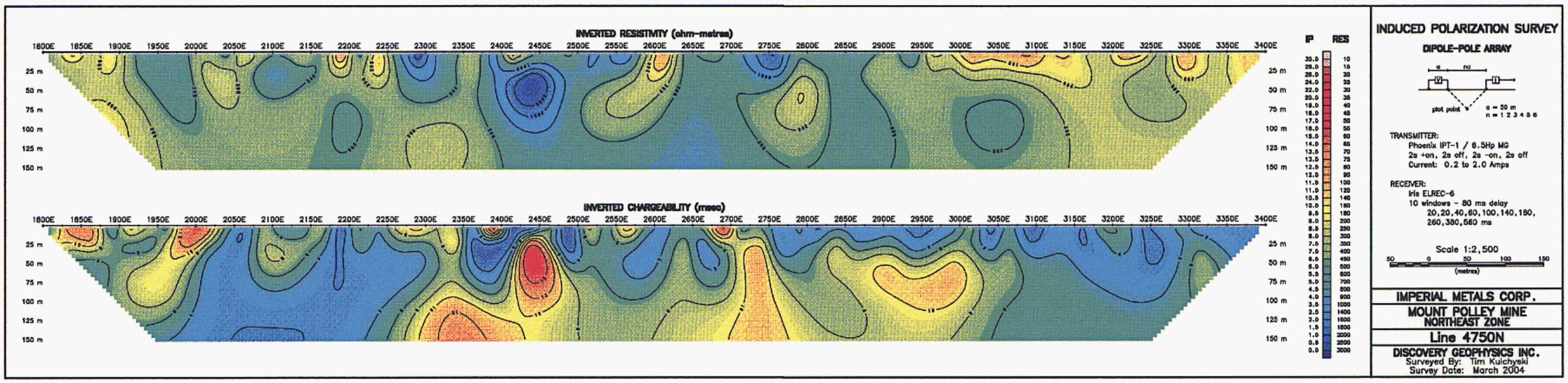
Mount Polley Northeast Zone
Induced Polarization Survey

Figure 17: Line 4700, Pseudo-sections and Inversion Sections

IMC

Associated Mining Consultants Ltd.

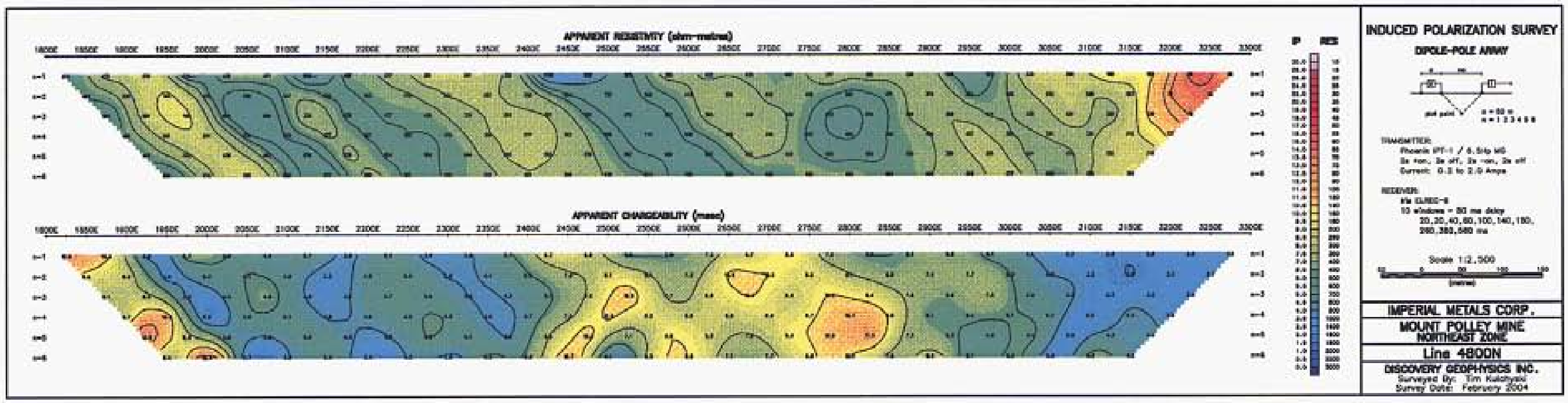


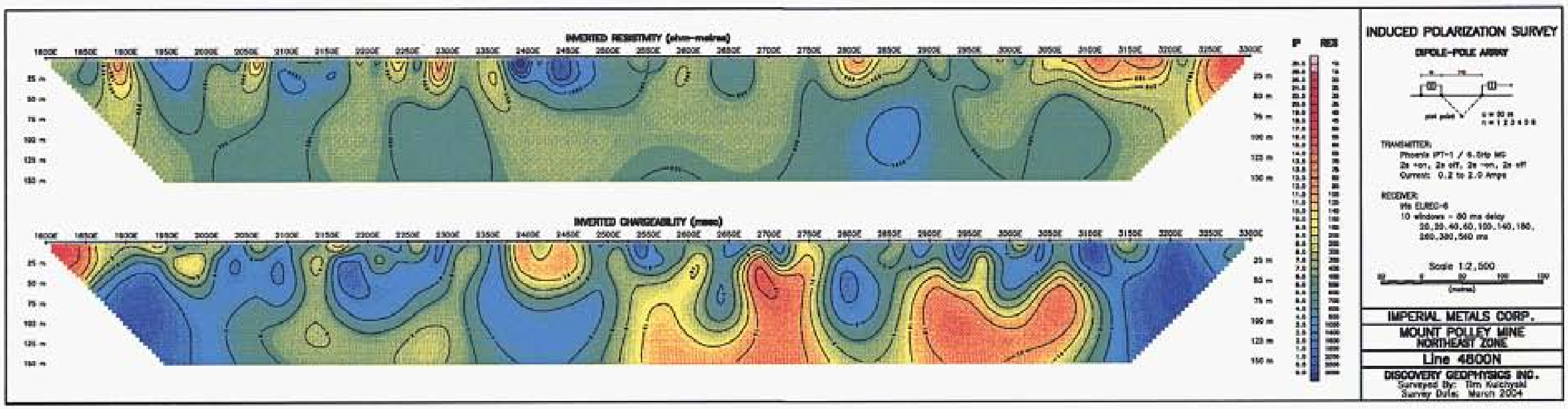


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 18: Line 4750, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

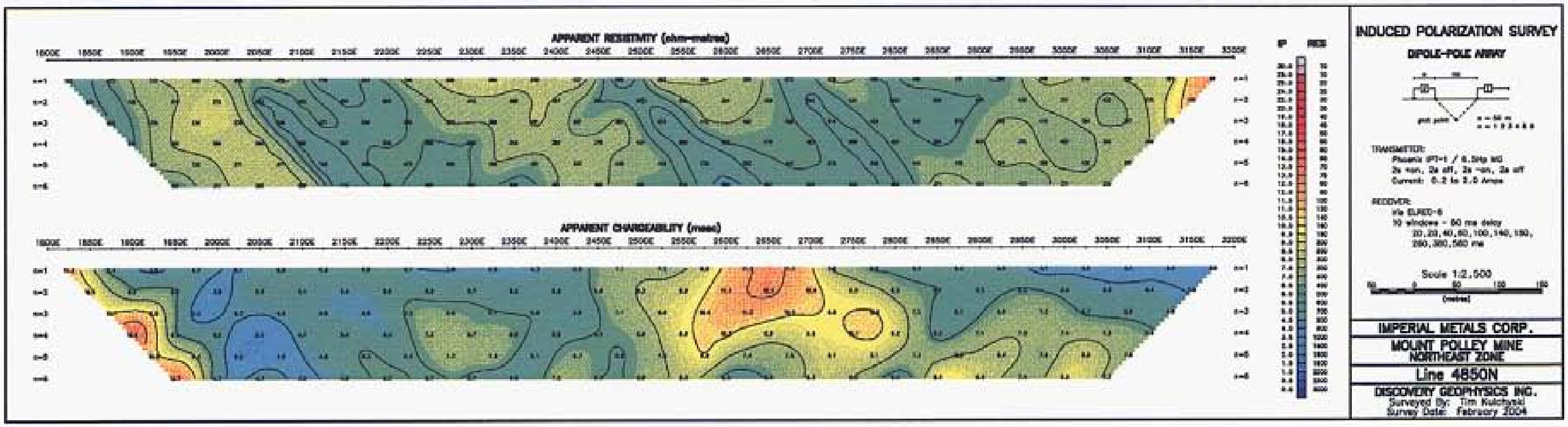


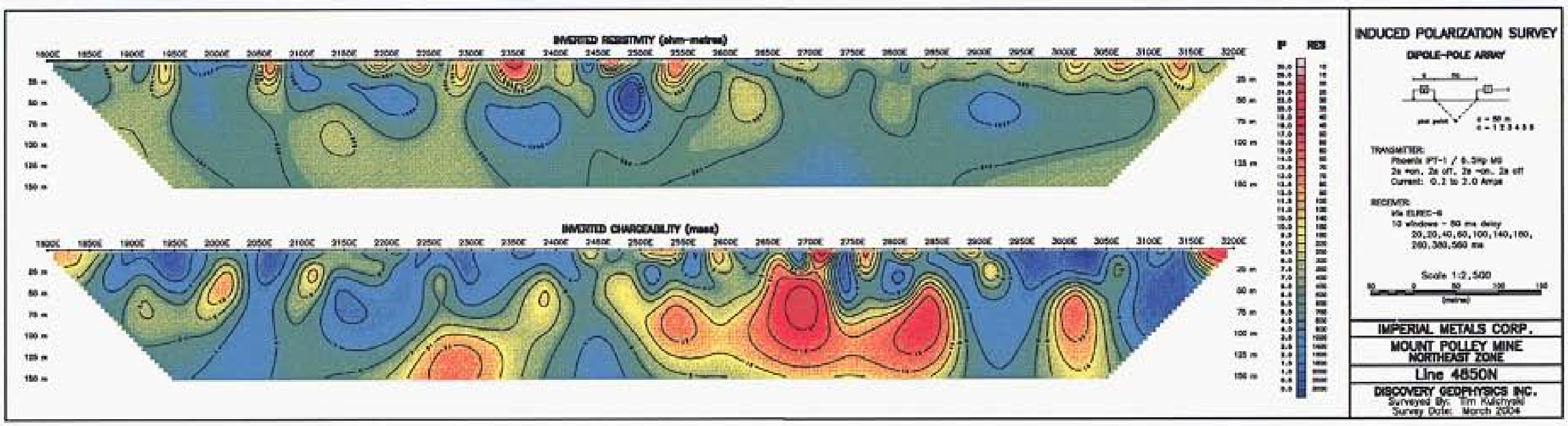


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 19: Line 4800, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

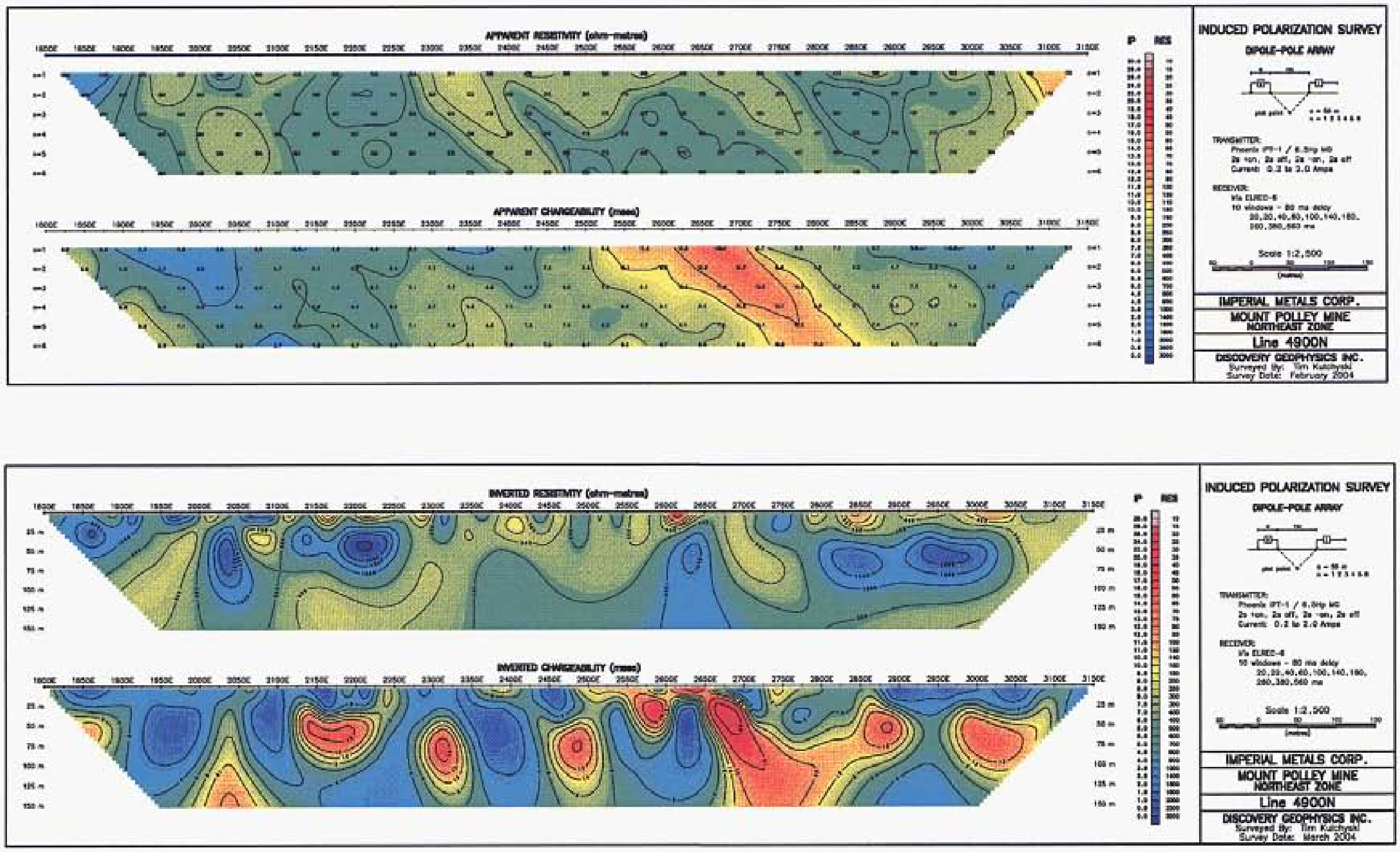




Mount Polley Northeast Zone
Induced Polarization Survey

Figure 20: Line 4850, Pseudo-sections and Inversion Sections

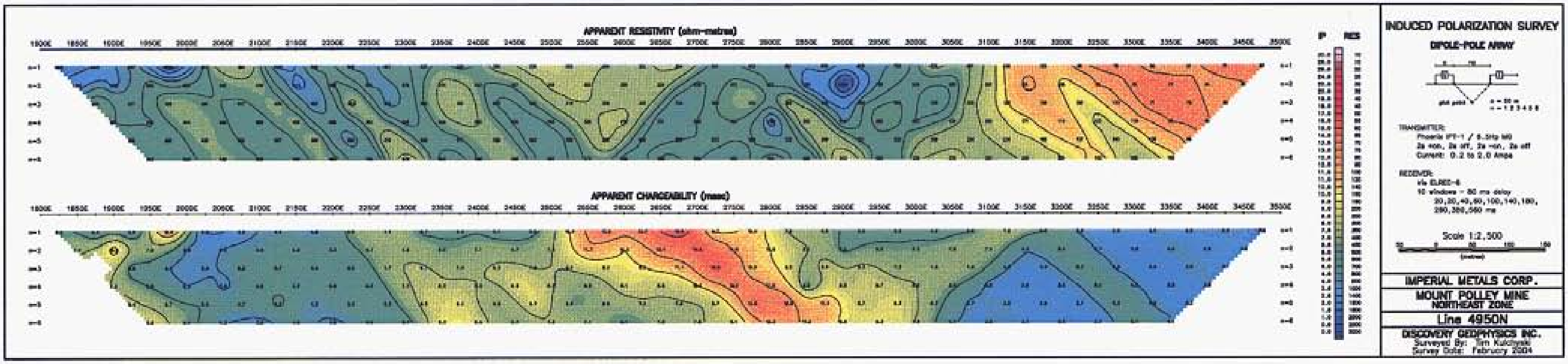
IMC
Associated Mining Consultants Ltd.

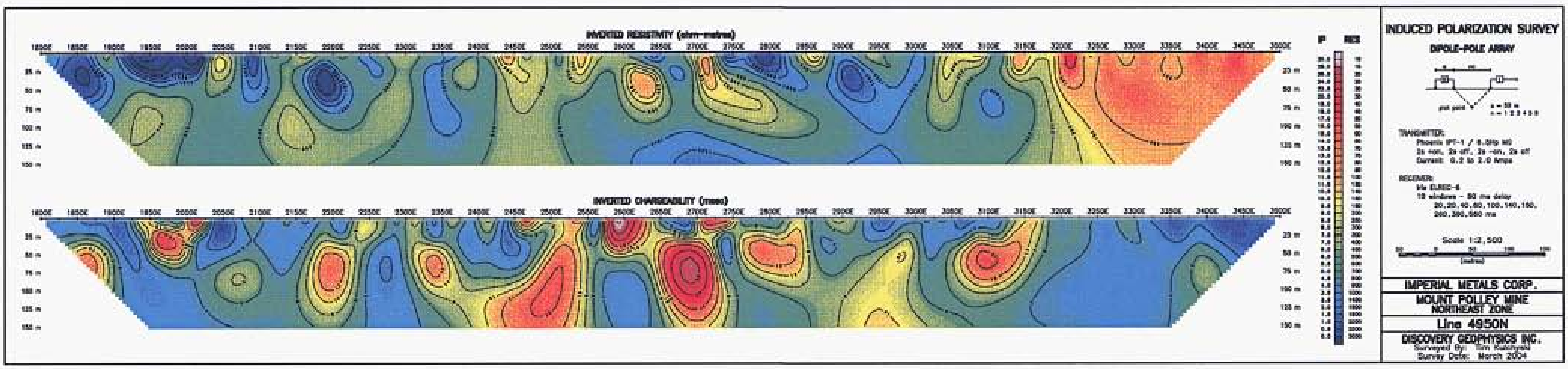


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 21: Line 4900, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

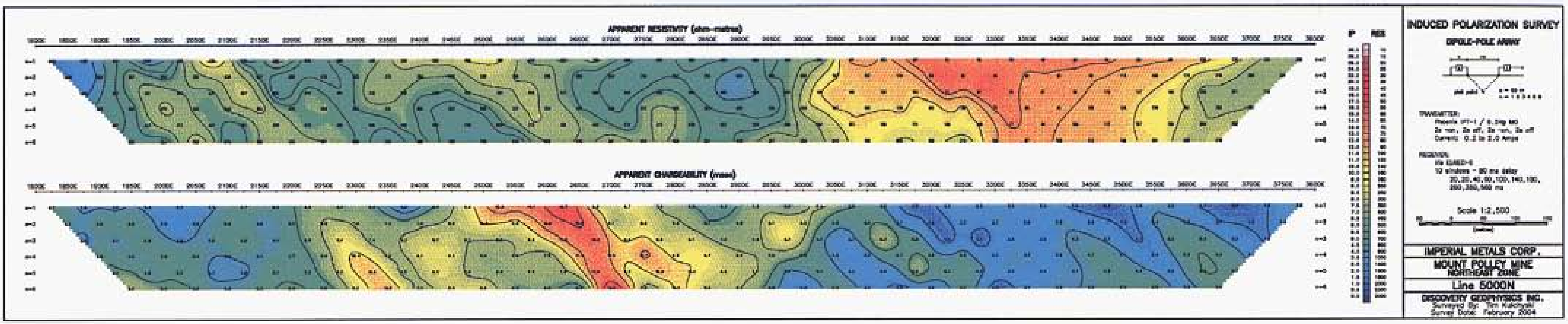


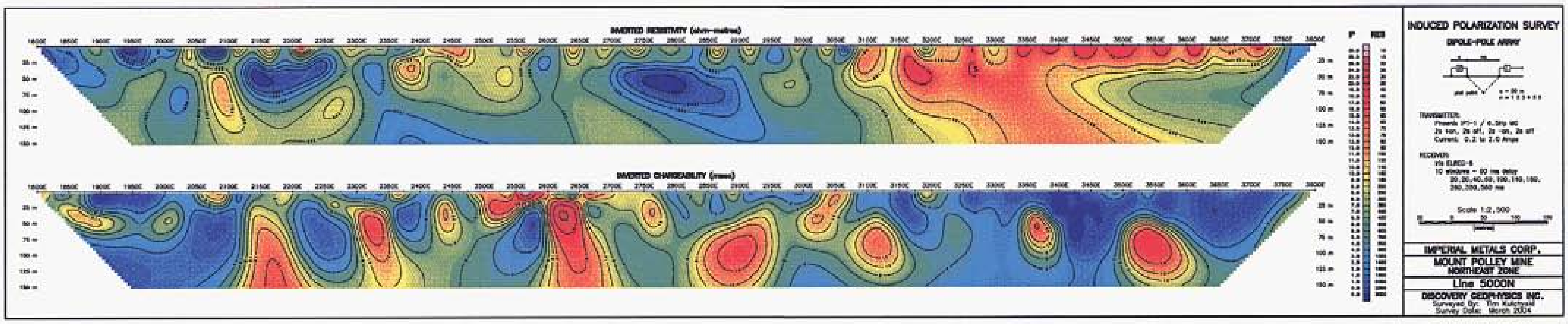


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 22: Line 4950, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.



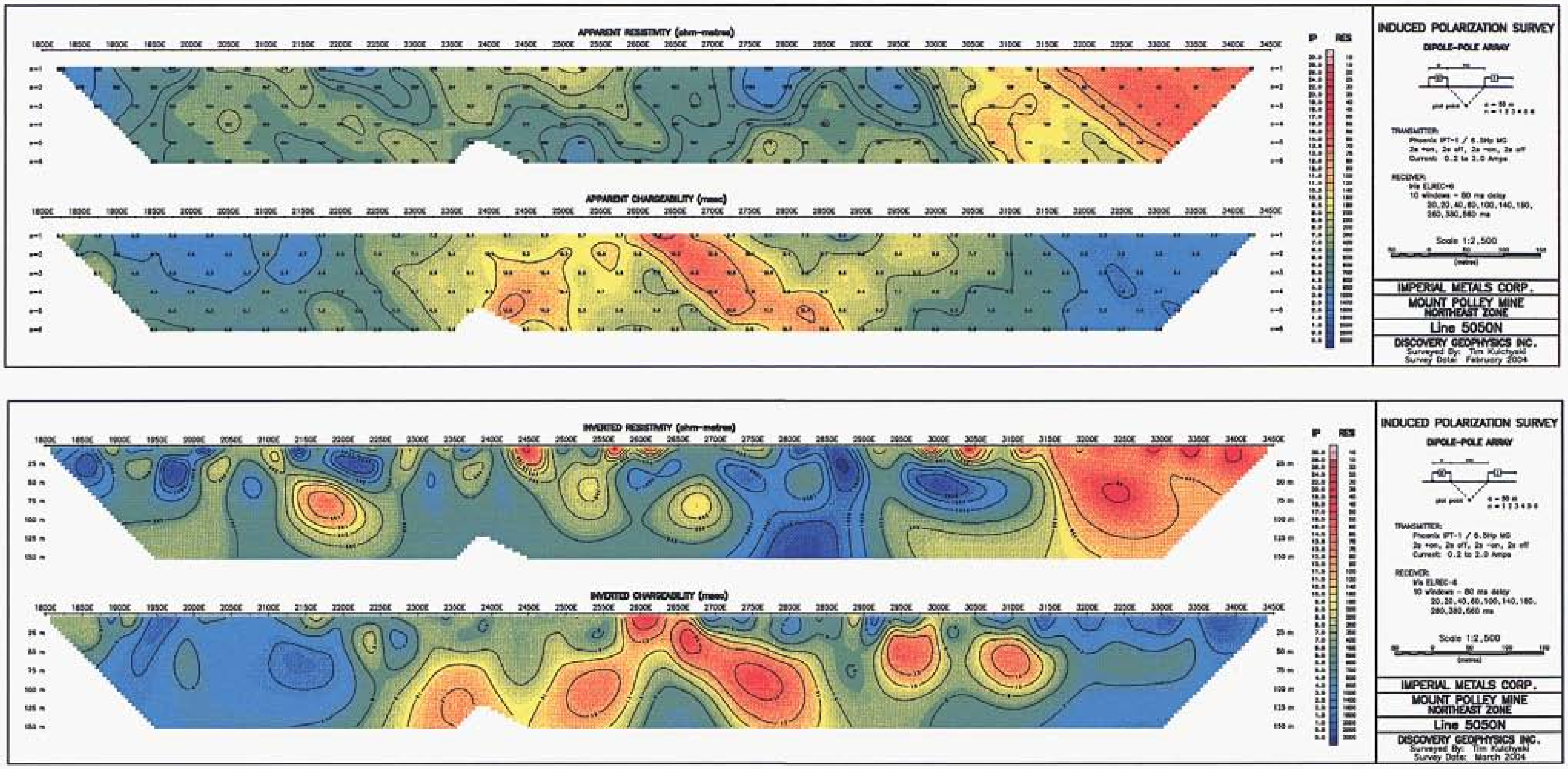


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 23: Line 5000, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

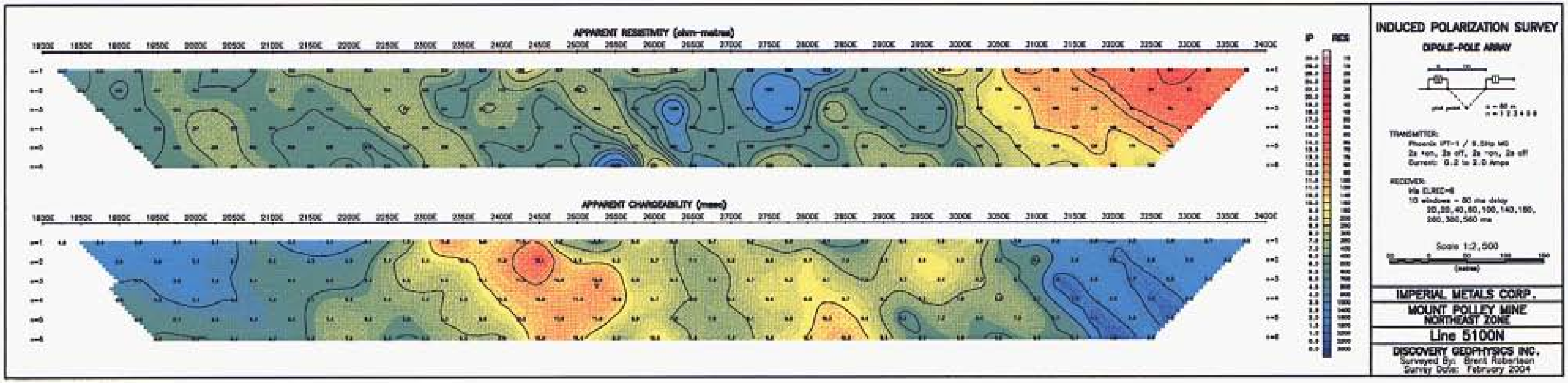
A20

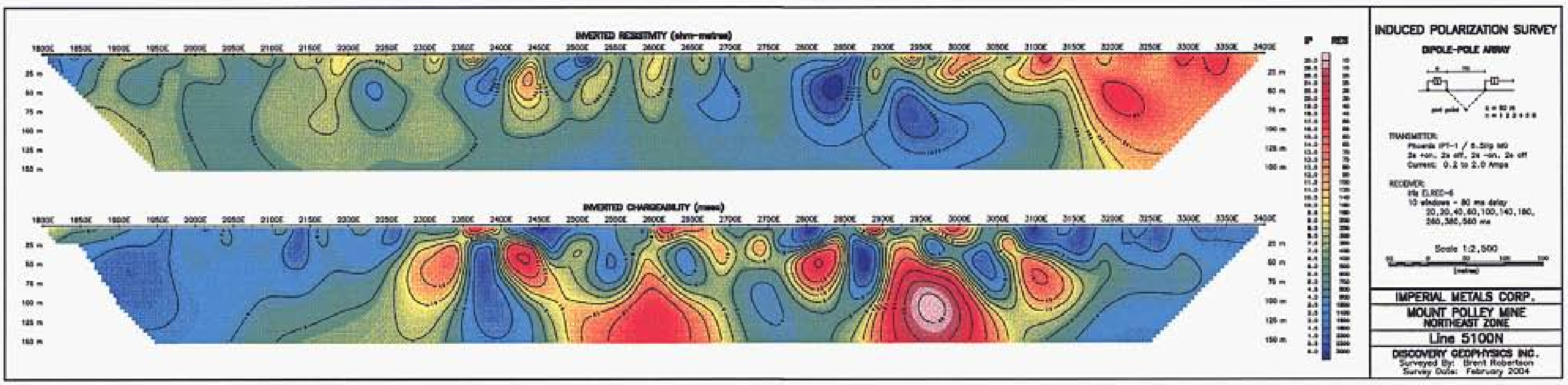


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 24: Line 5050, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

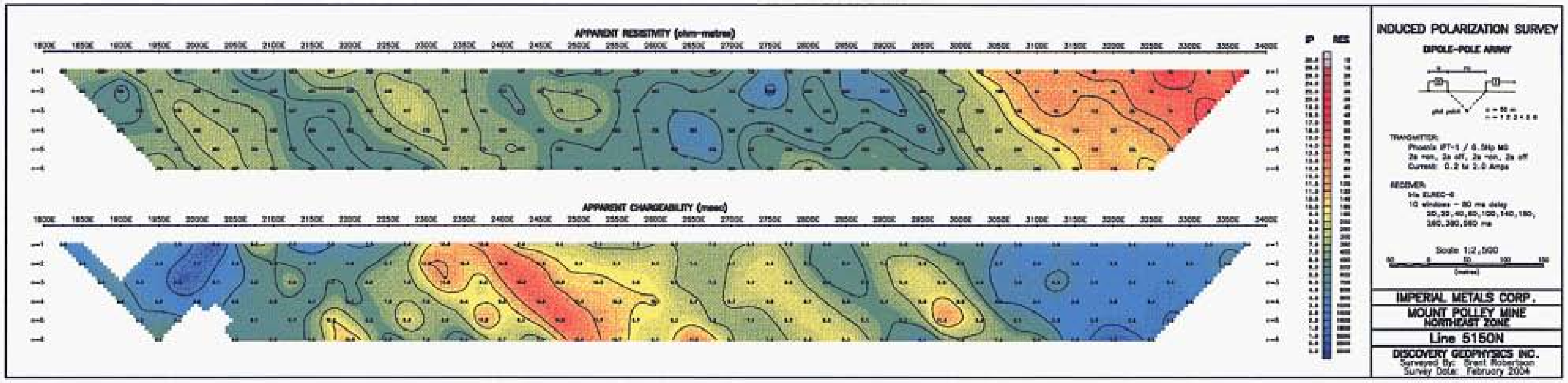


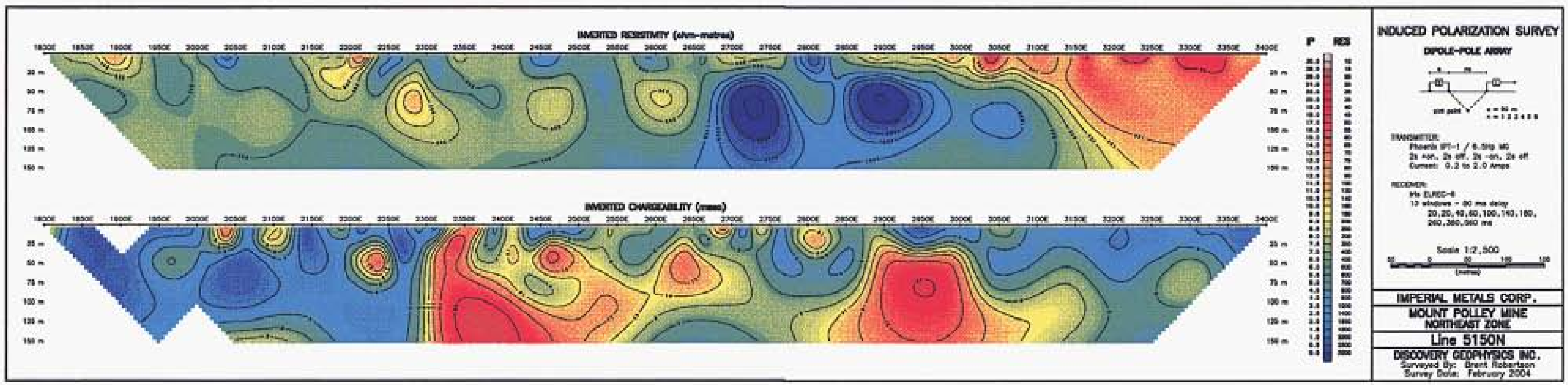


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 25: Line 5100, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

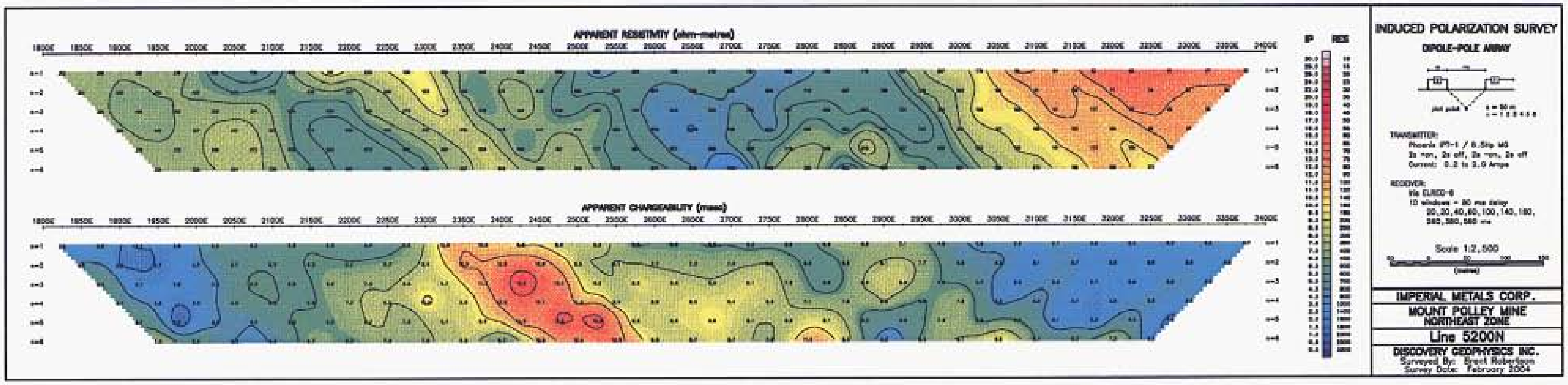


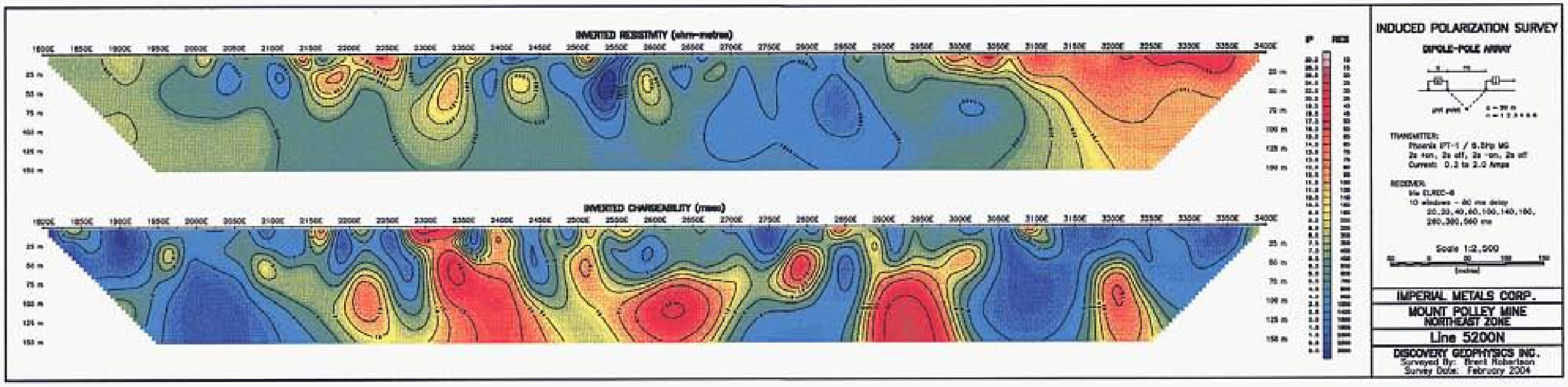


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 26: Line 5150, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

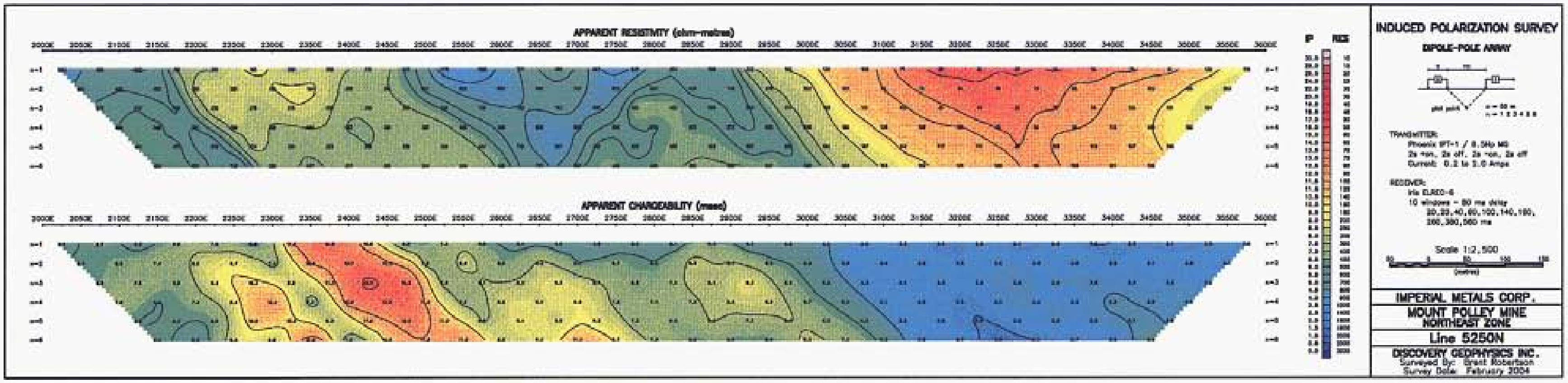


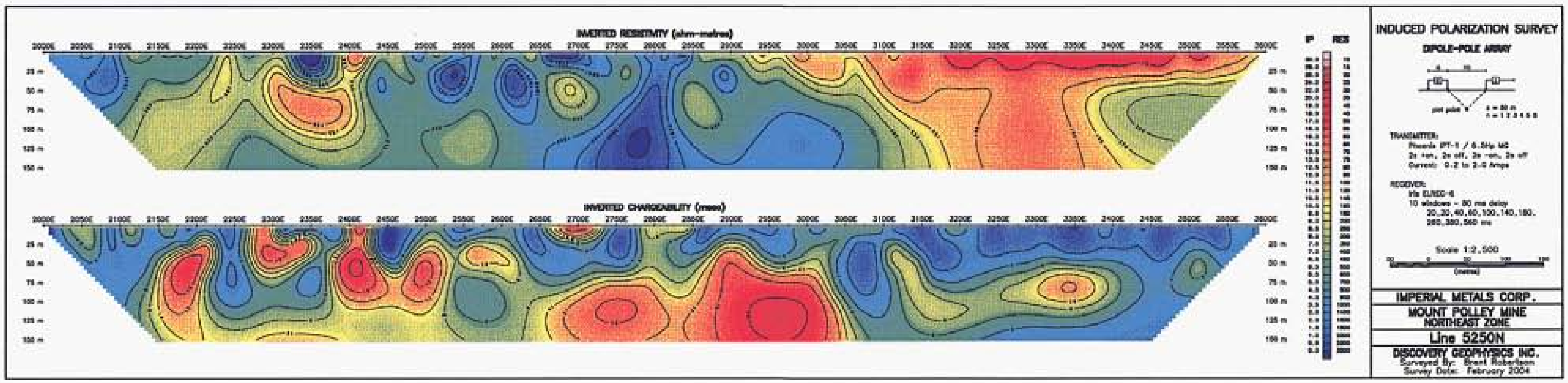


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 27: Line 5200, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

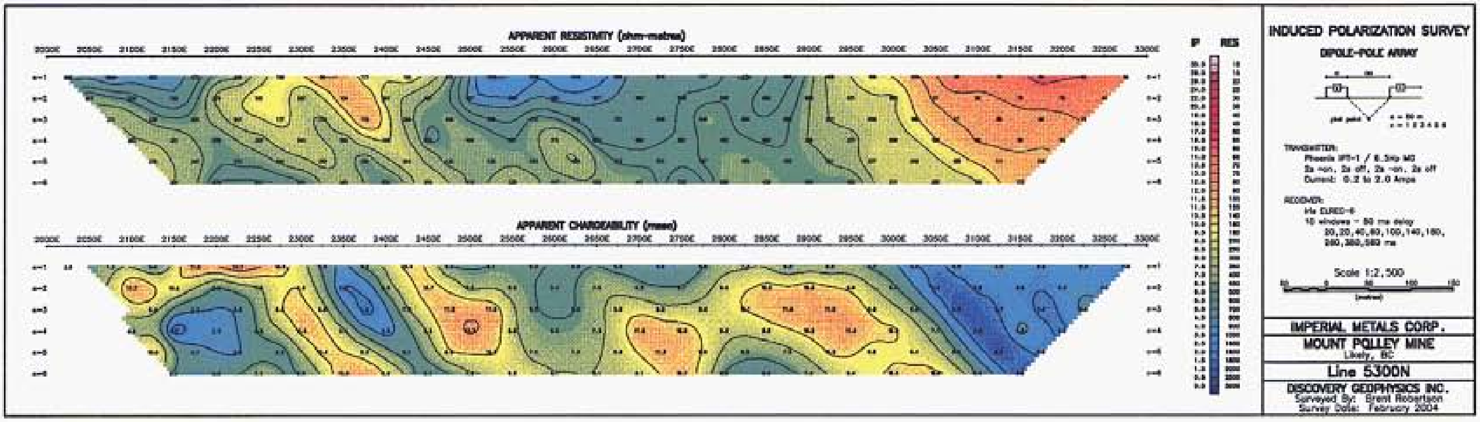


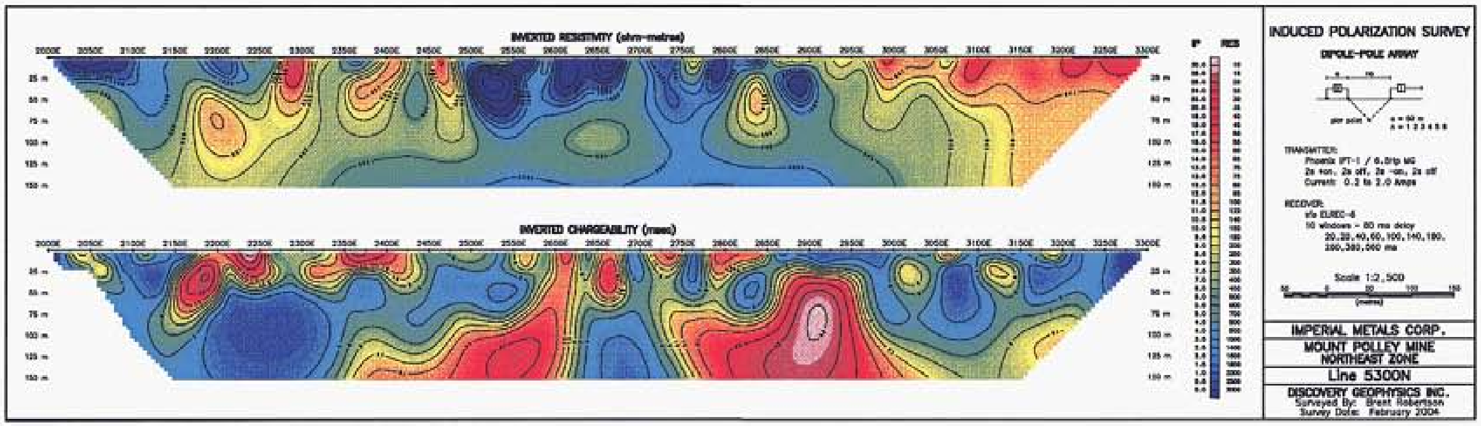


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 28: Line 5250, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.





Mount Polley Northeast Zone
Induced Polarization Survey

Figure 29: Line 5300, Pseudo-sections and Inversion Sections

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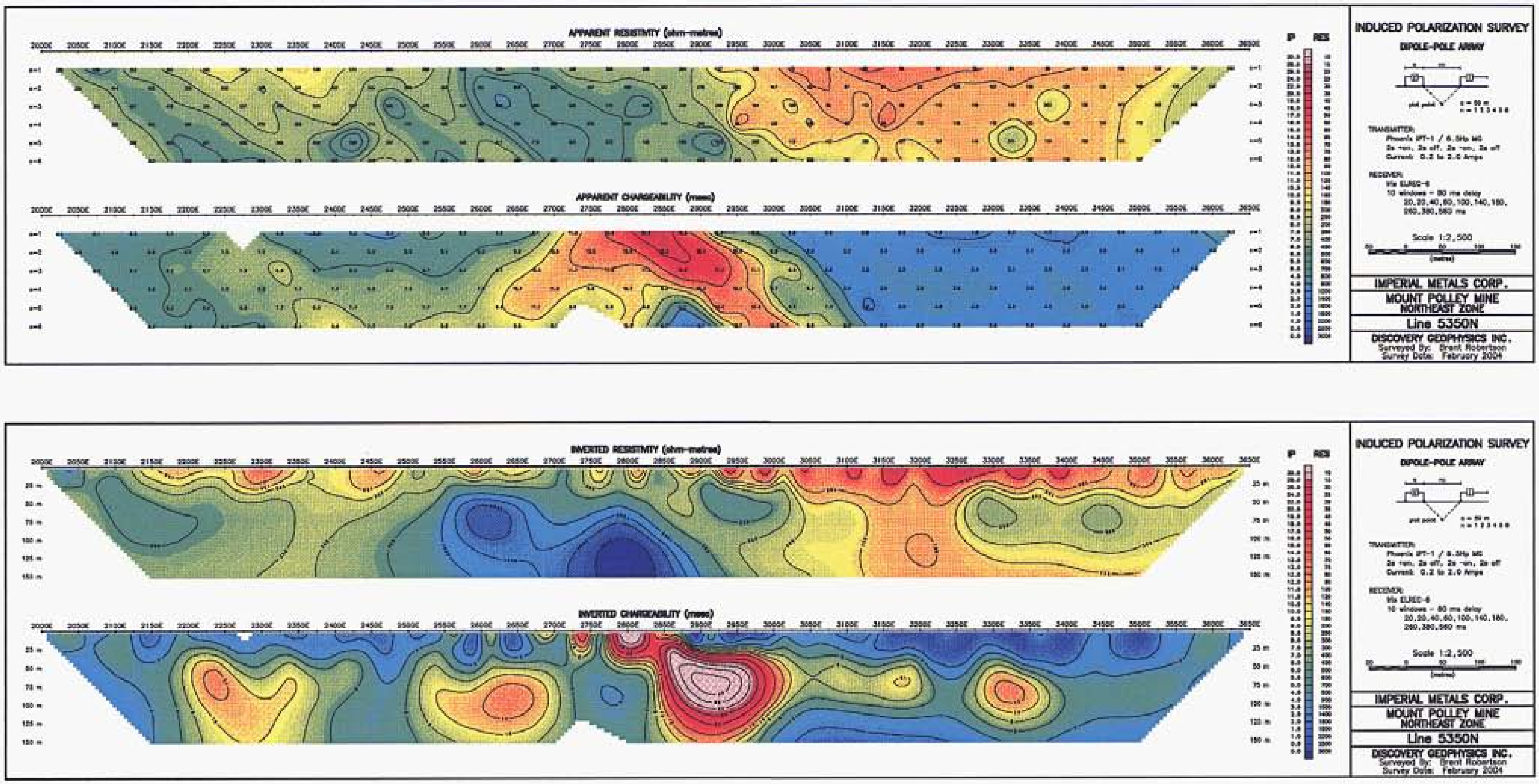
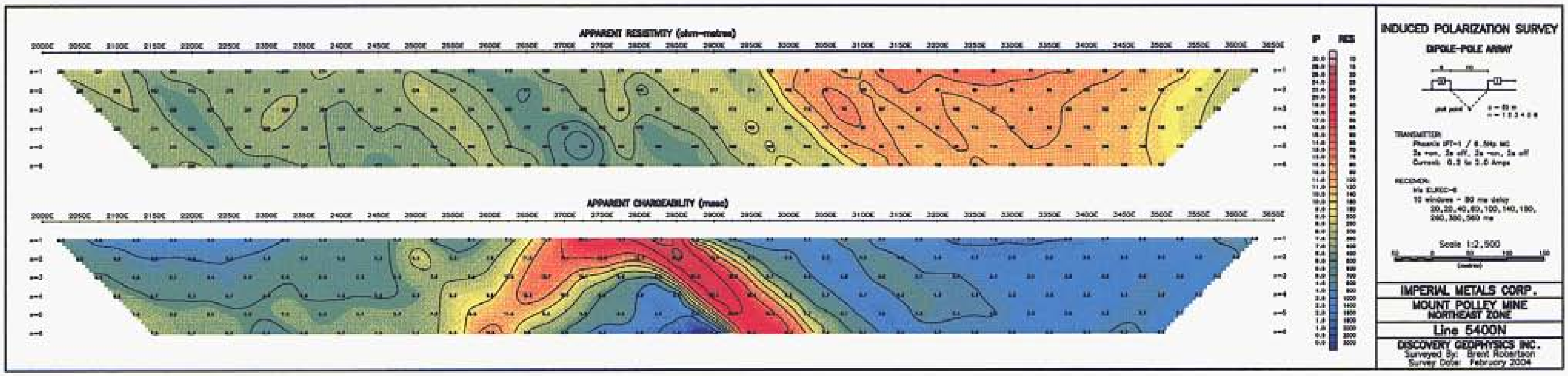
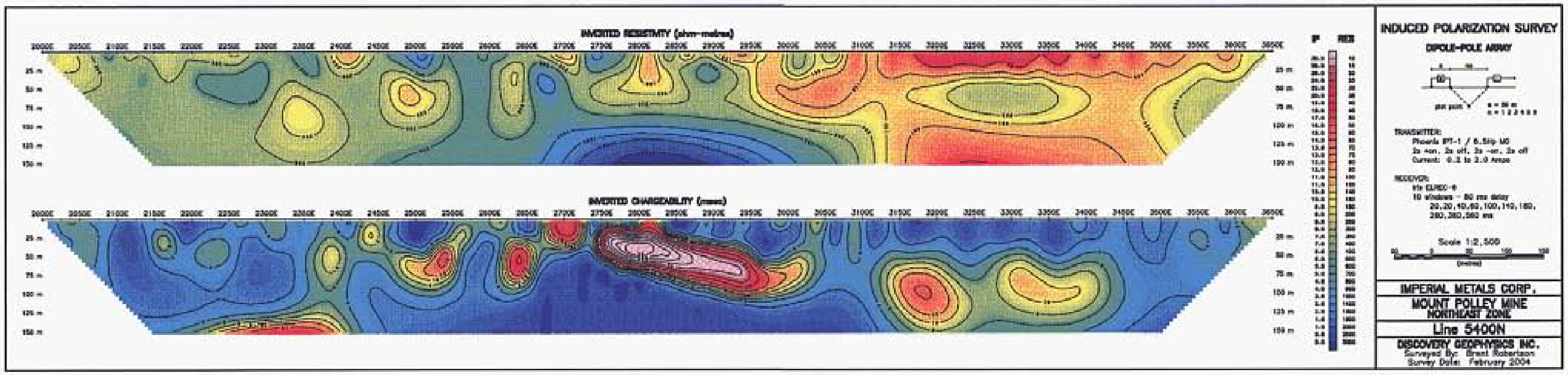


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 30: Line 5350, Pseudo-sections and Inversion Sections

Associated Mining Consultants Ltd.





Mount Polley Northeast Zone
Induced Polarization Survey

Figure 31: Line 5400, Pseudo-sections and Inversion Sections

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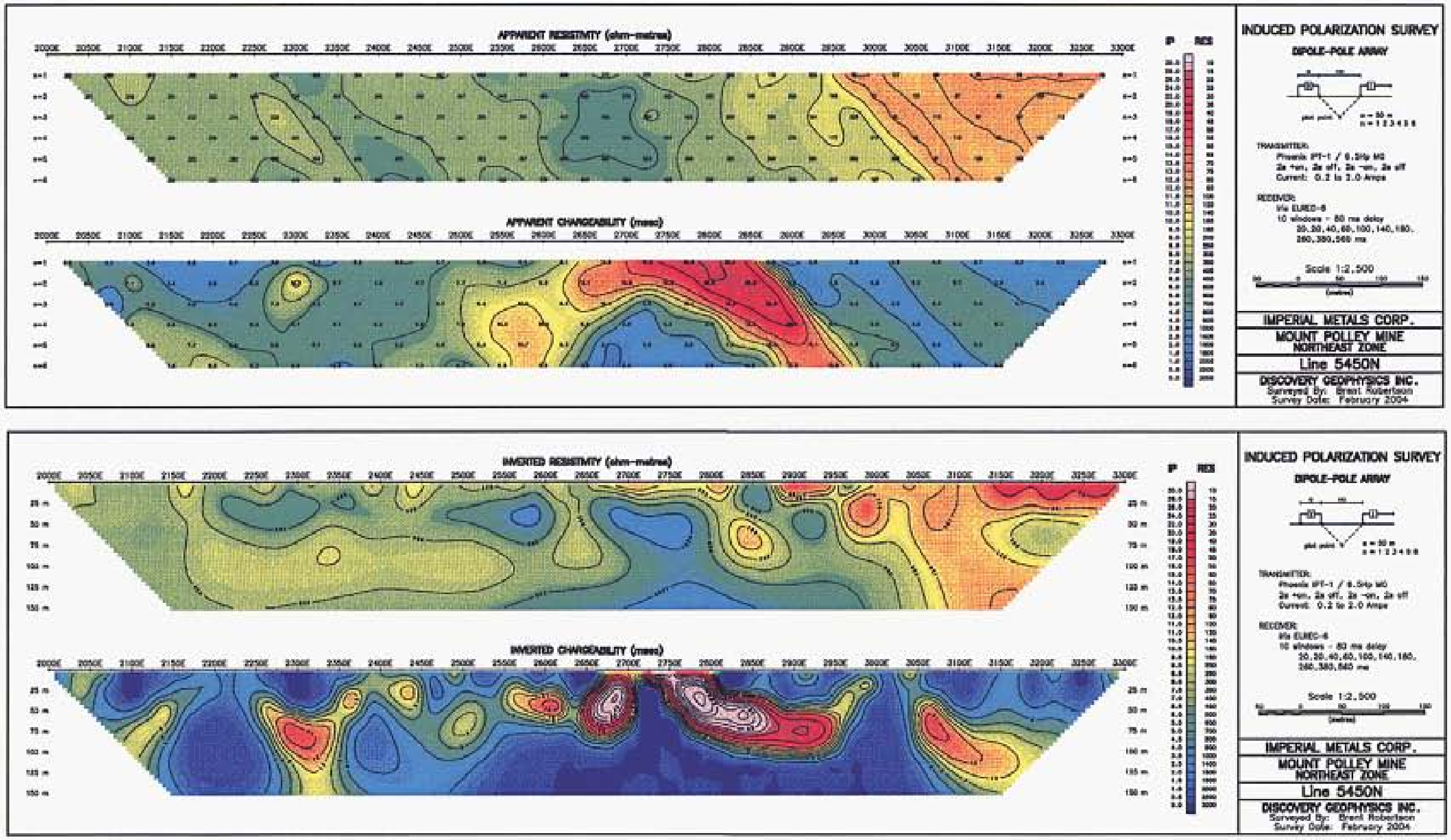

Mount Polley Northeast Zone
Induced Polarization Survey

Figure 32: Line 5450, Pseudo-sections and Inversion Sections

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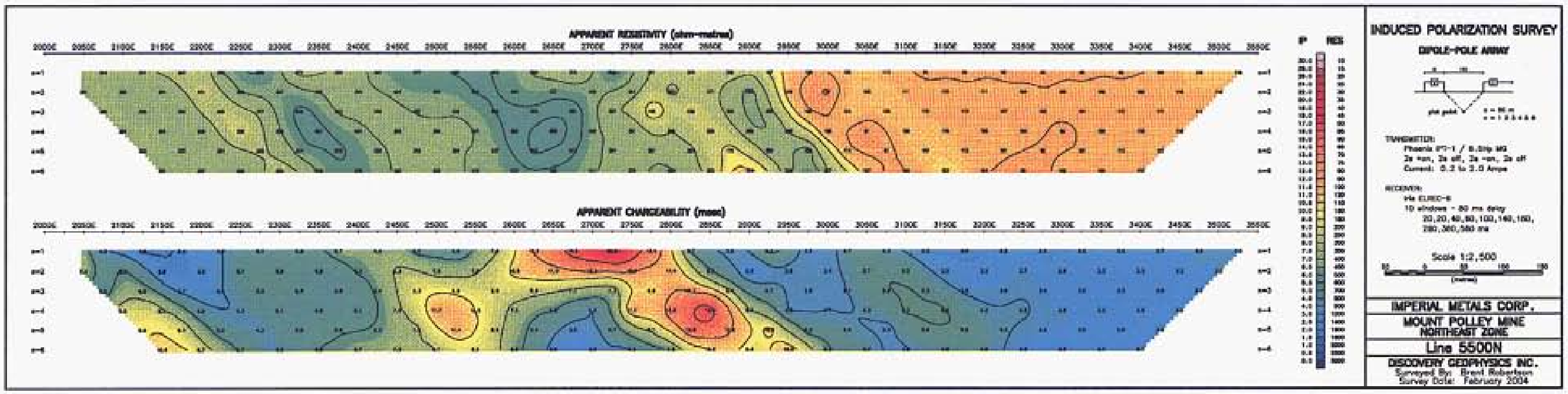
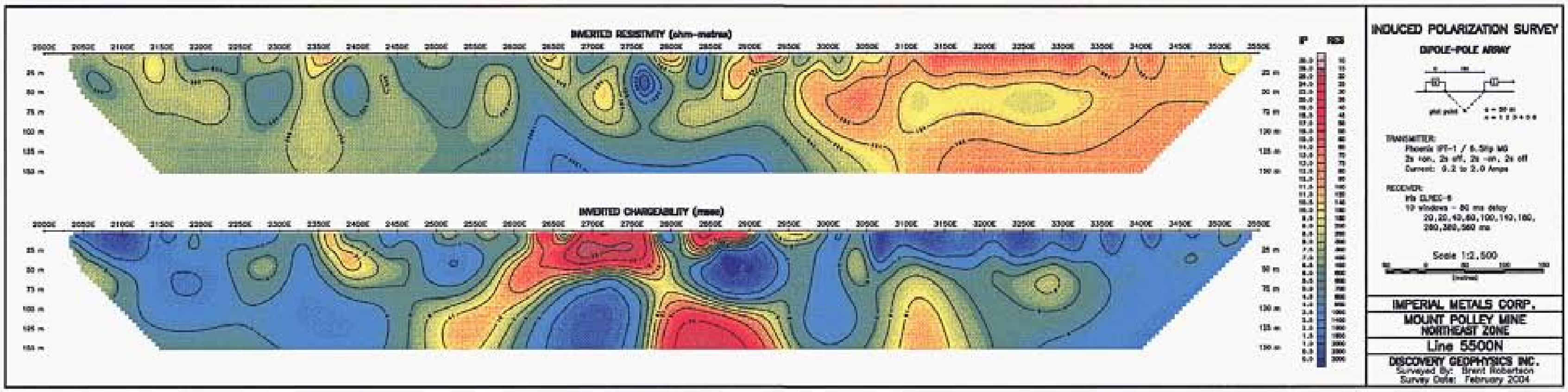
A29





Mount Polley Northeast Zone
Induced Polarization Survey

Figure 33: Line 5500, Pseudo-sections and Inversion Sections

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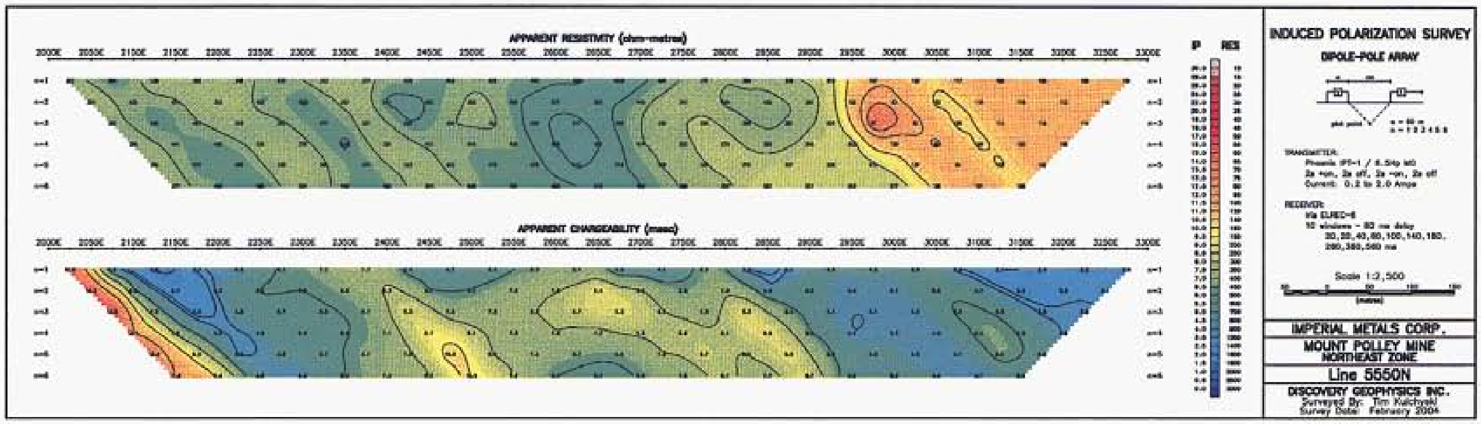
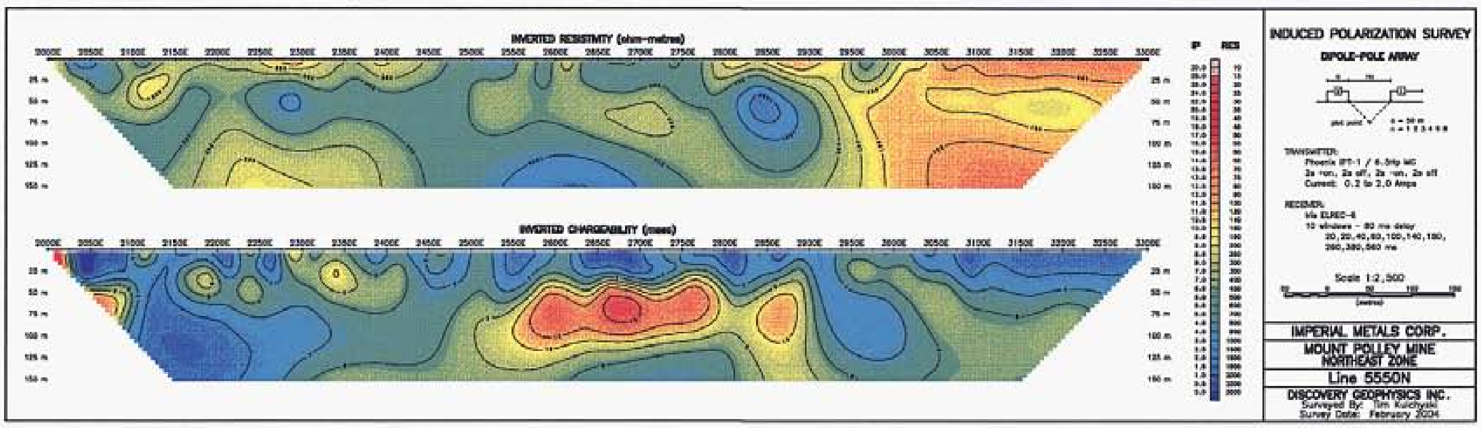
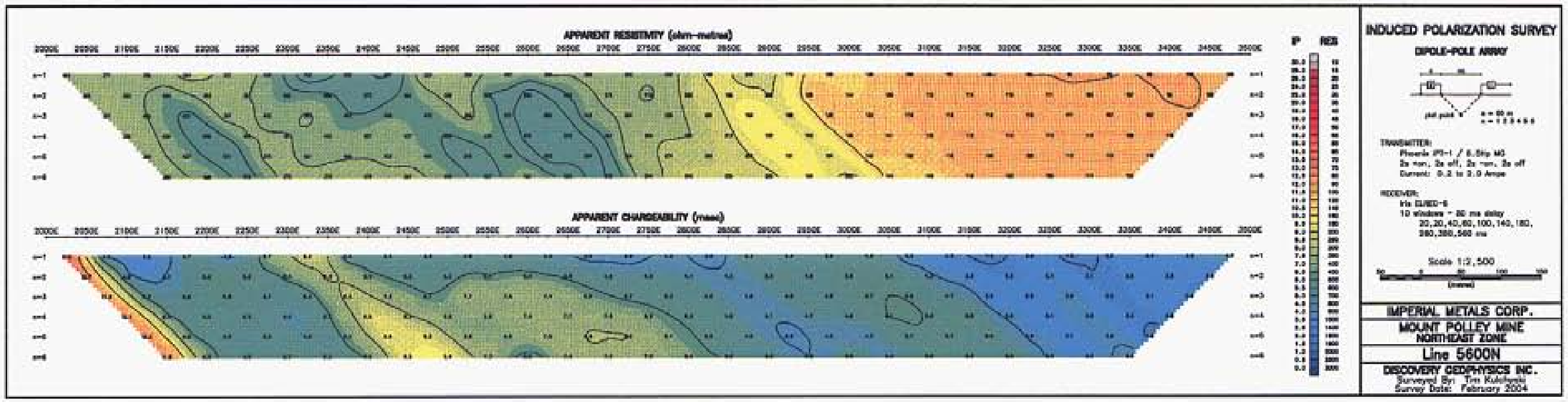


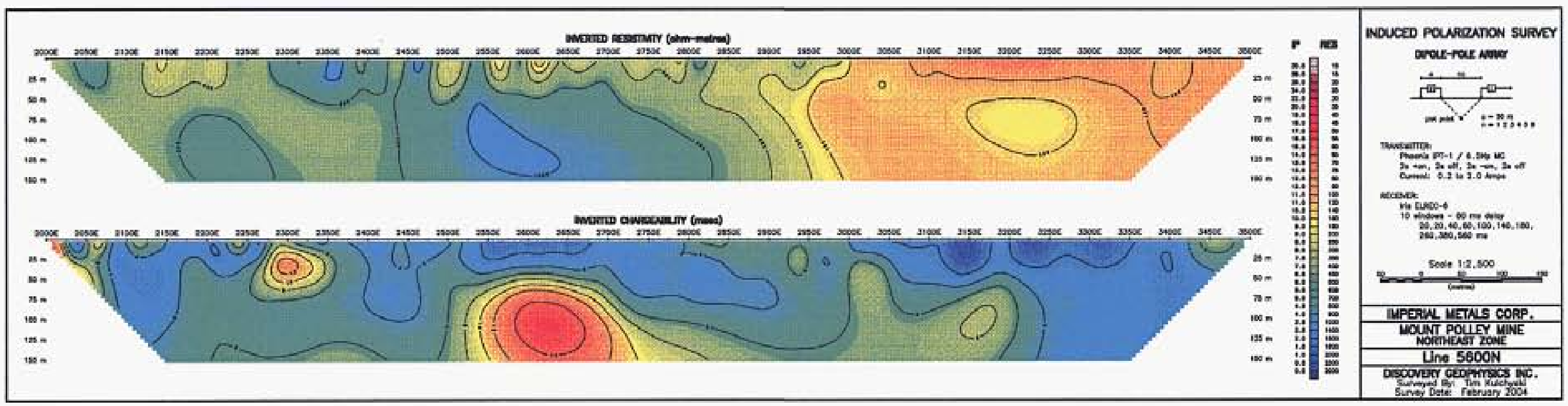


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 34: Line 5550, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.





Mount Polley Northeast Zone
Induced Polarization Survey

Figure 35: Line 5600, Pseudo-sections and Inversion Sections

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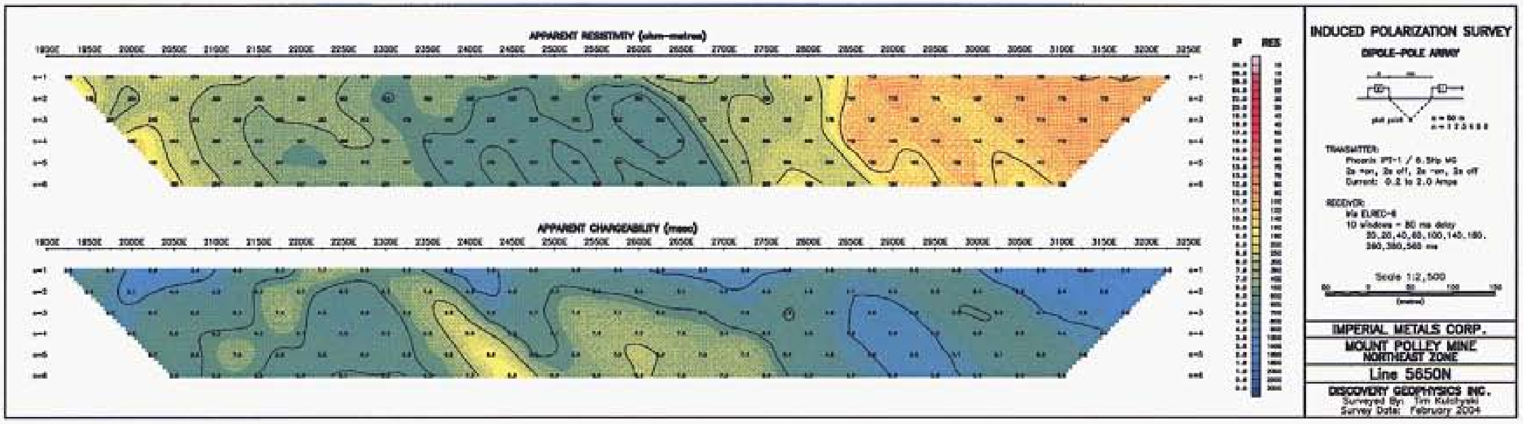
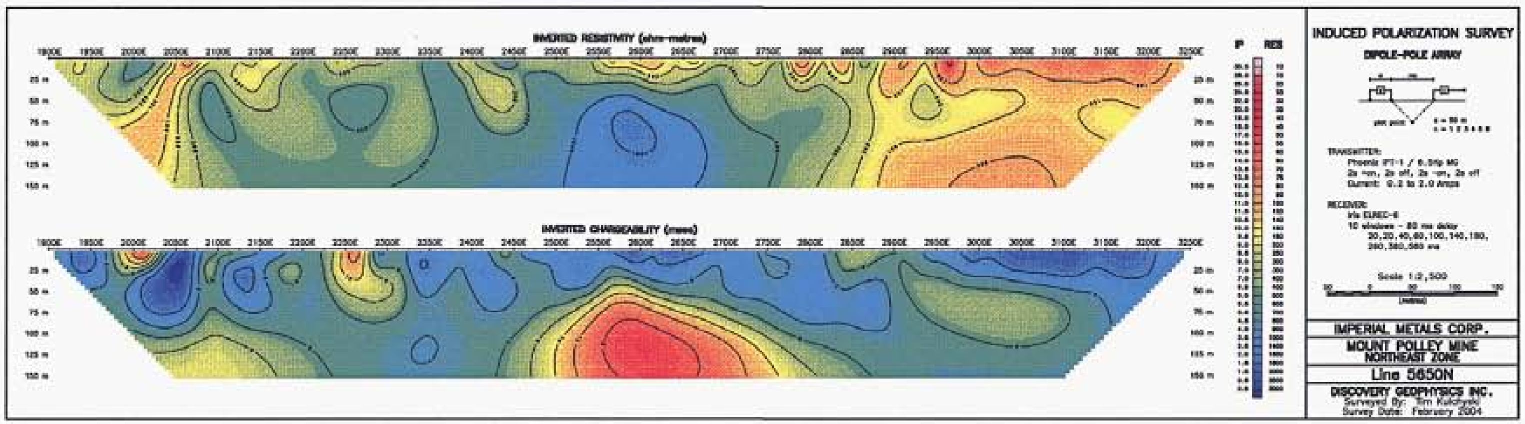
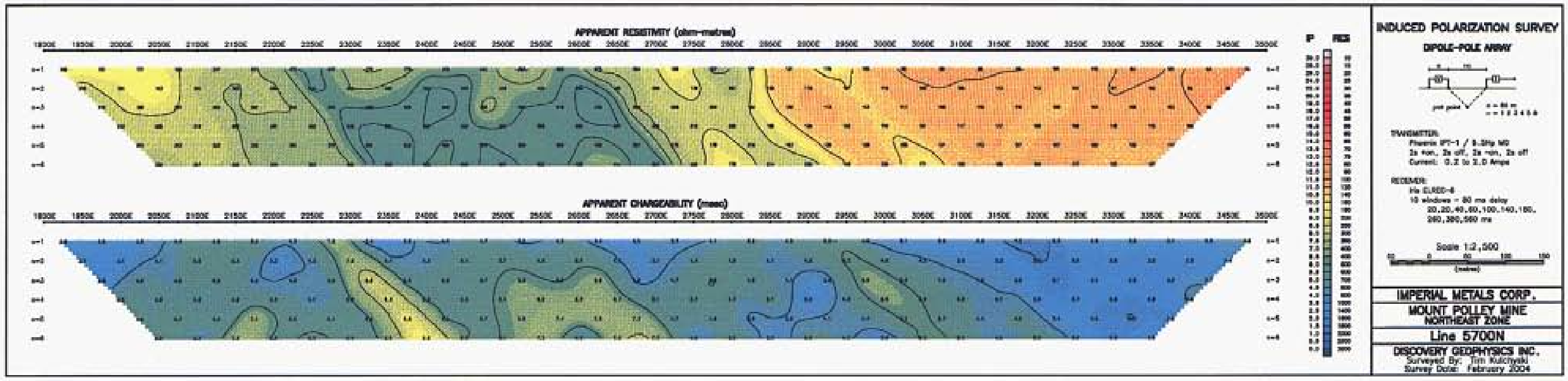


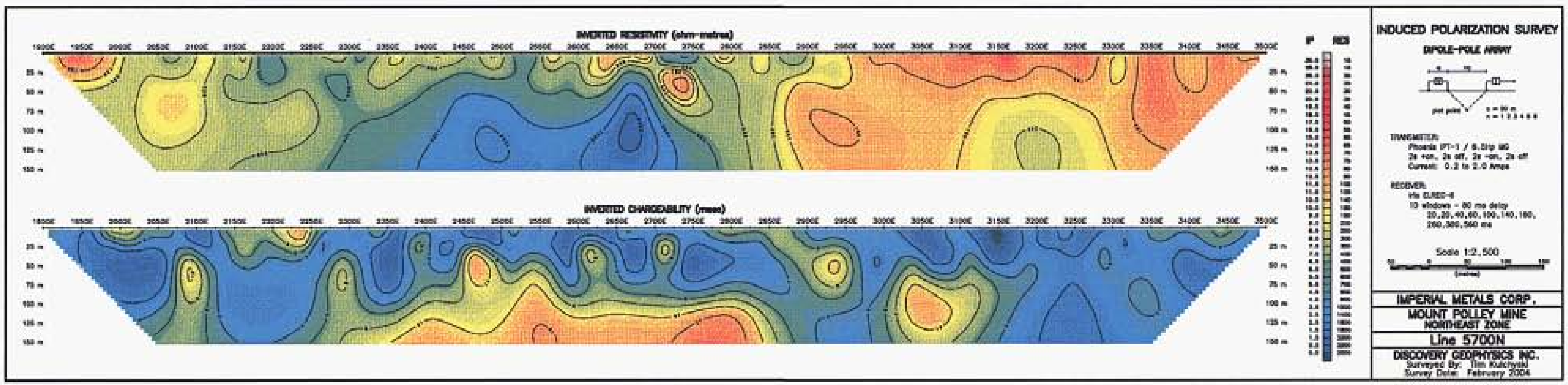


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 36: Line 5650, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

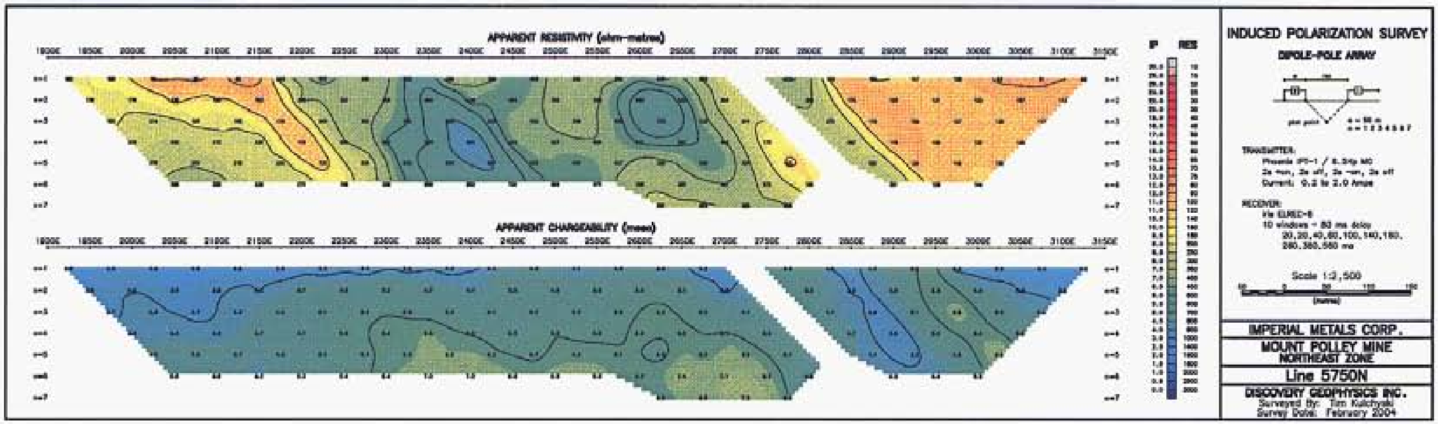


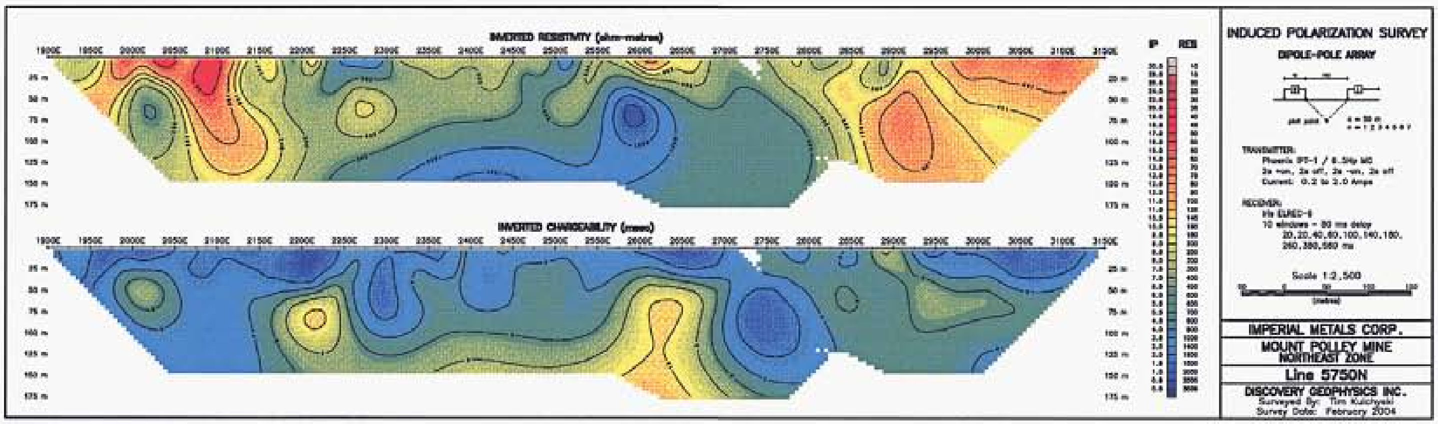


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 37: Line 5700, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

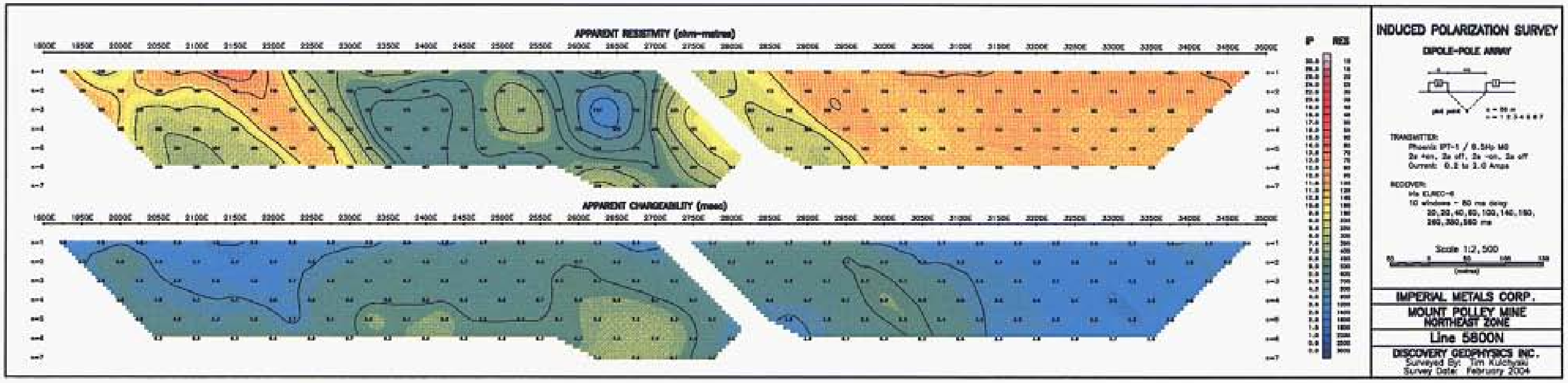


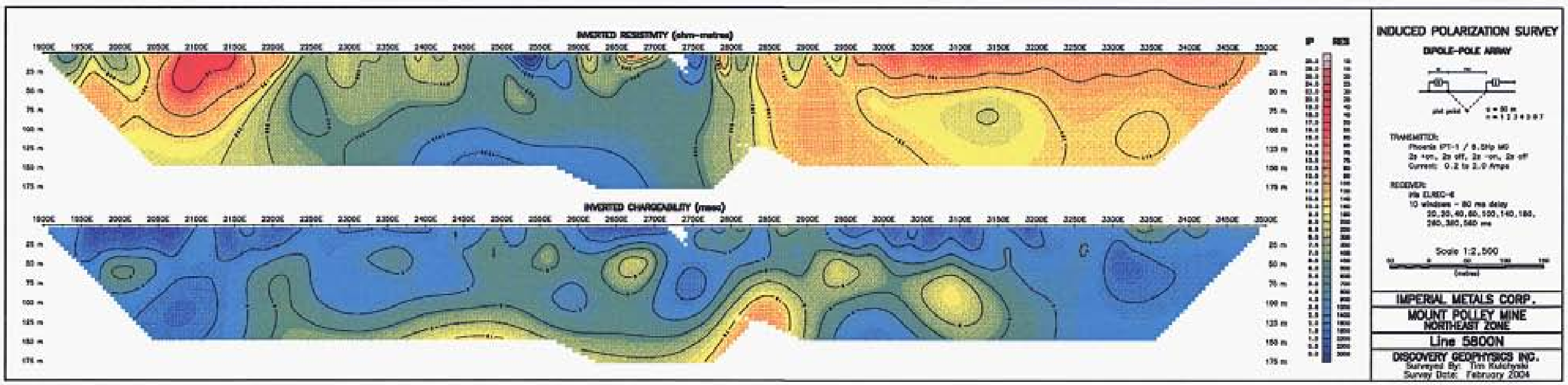


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 38: Line 5750, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

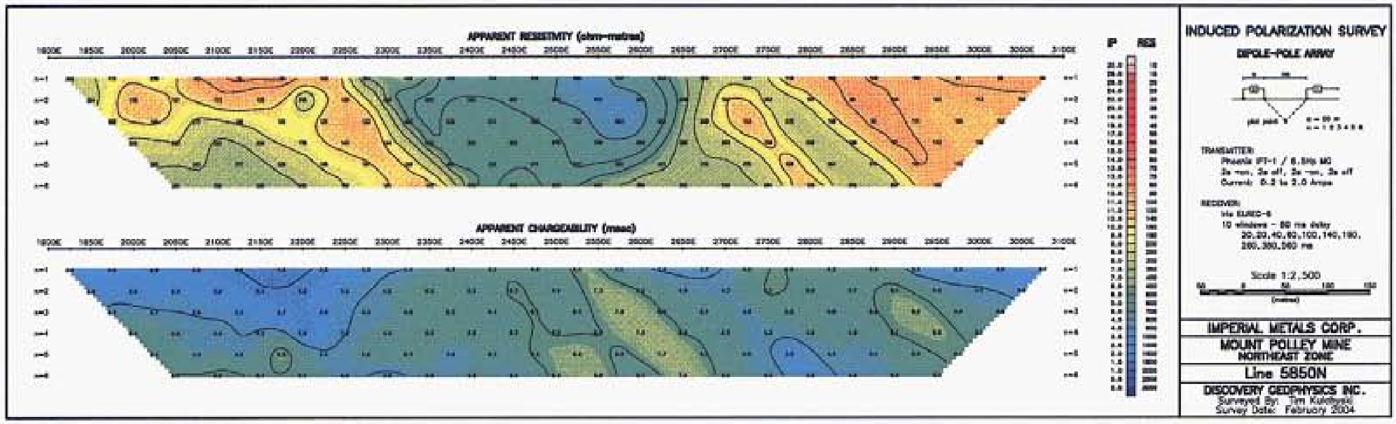


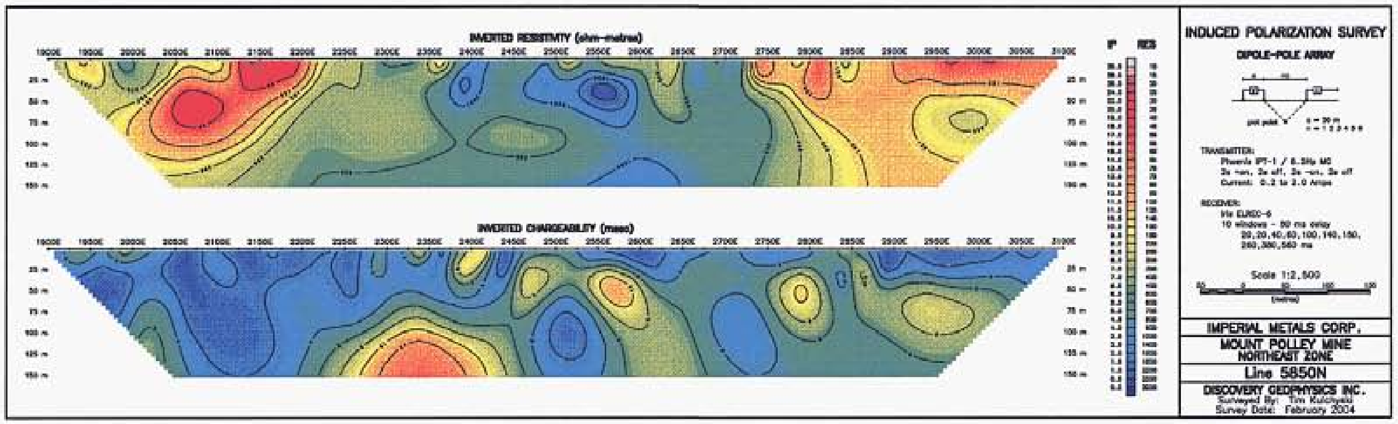


Mount Polley Northeast Zone
Induced Polarization Survey

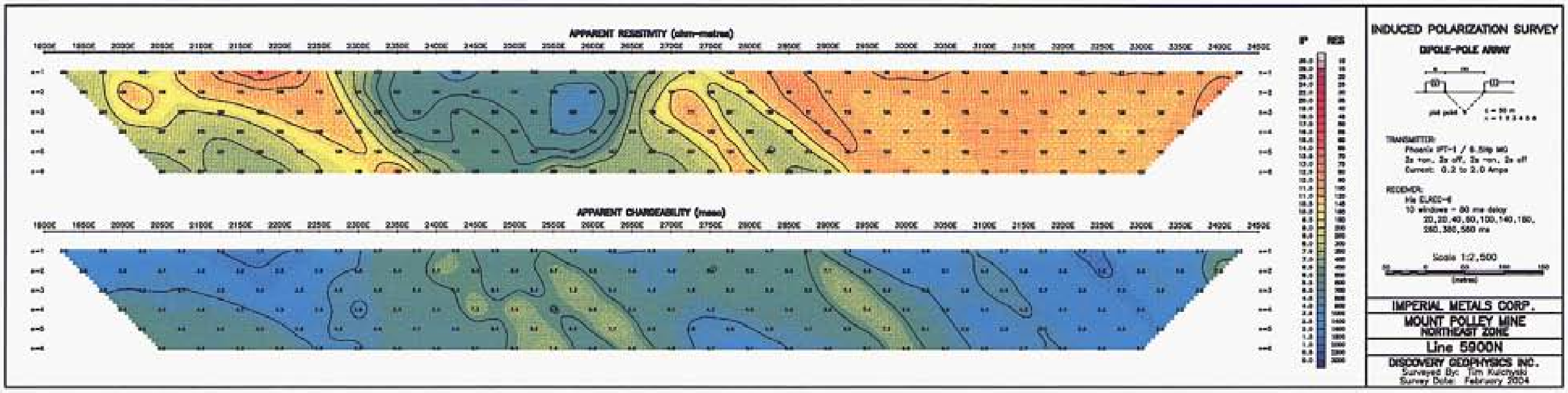
Figure 39: Line 5800, Pseudo-sections and Inversion Sections

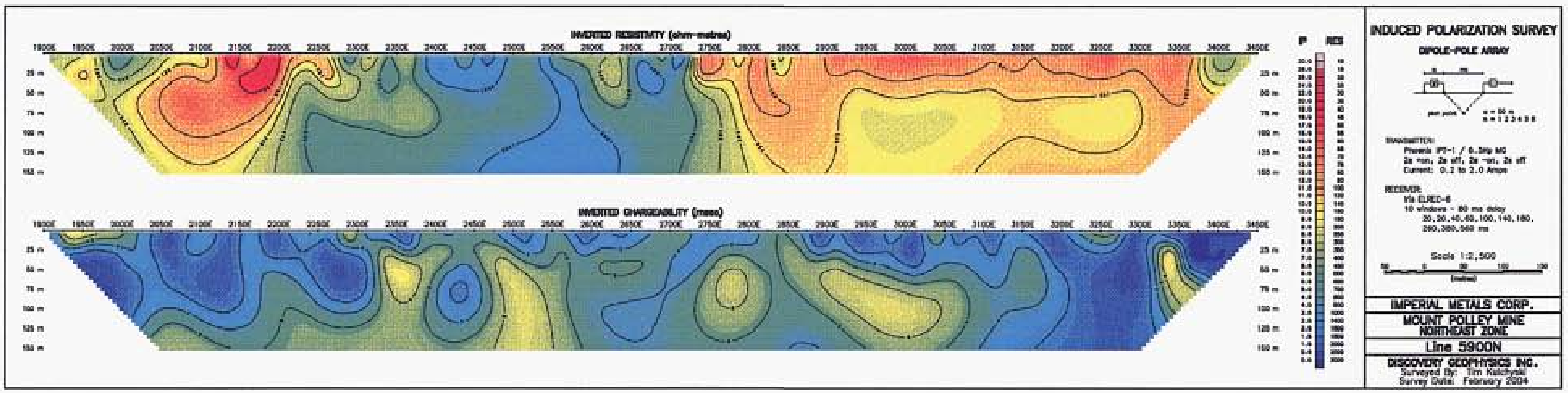
IMC
Associated Mining Consultants Ltd.





Mount Polley Northeast Zone Induced Polarization Survey
Figure 40: Line 5850, Pseudo-sections and Inversion Sections
IMC
Associated Mining Consultants Ltd.

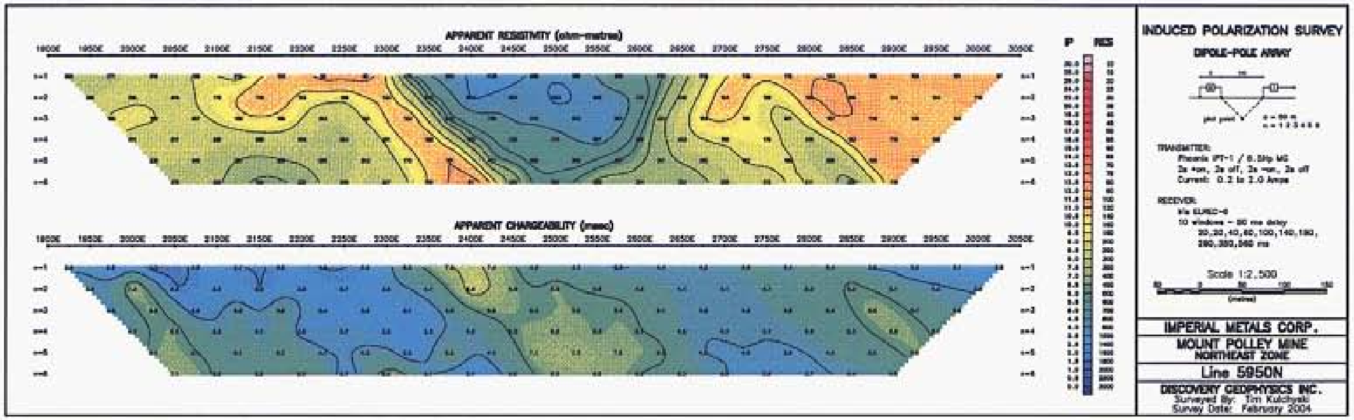


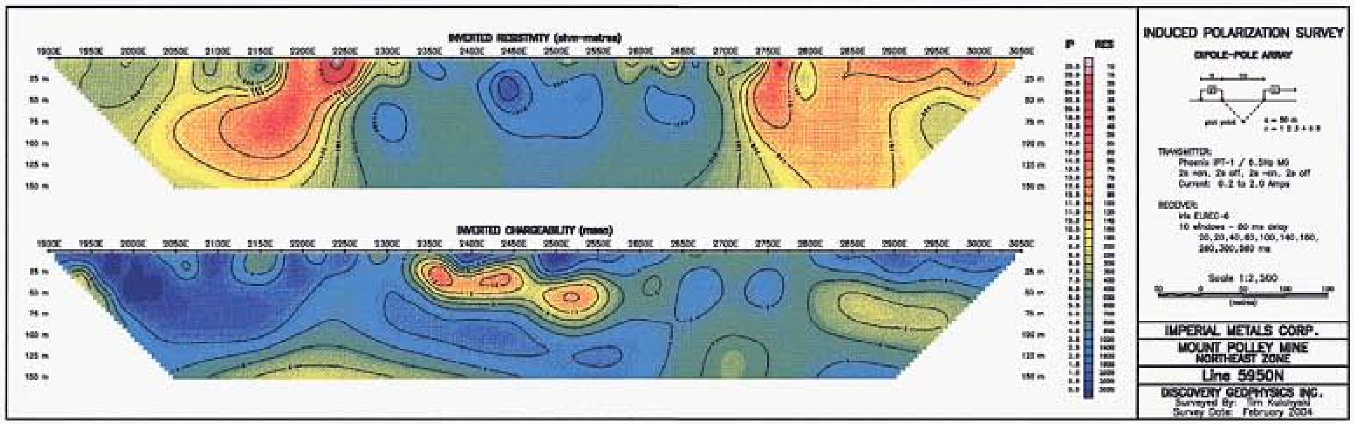


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 41: Line 5900, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

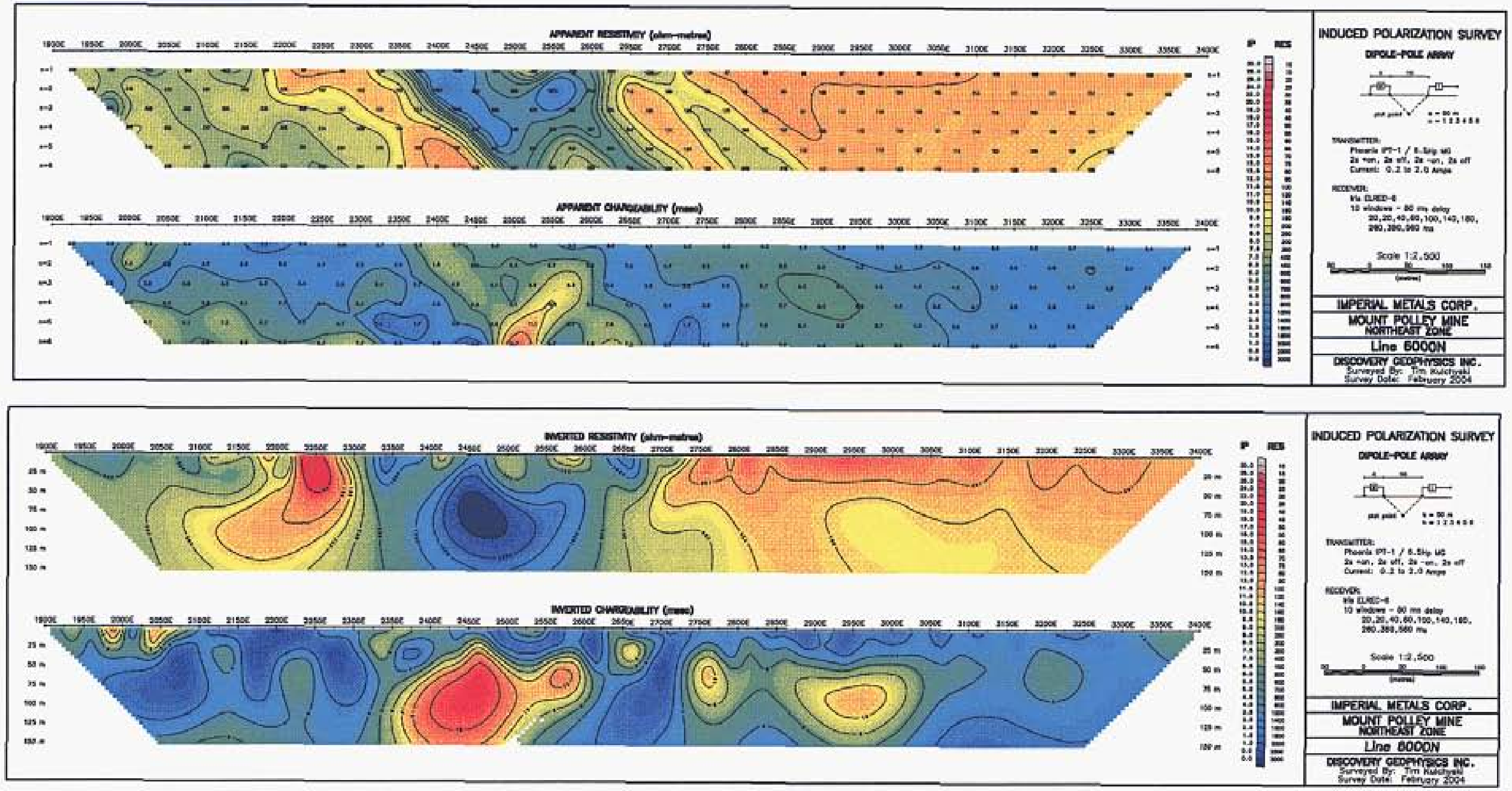




Mount Polley Northeast Zone
Induced Polarization Survey

Figure 42: Line 5950, Pseudo-sections and Inversion Sections

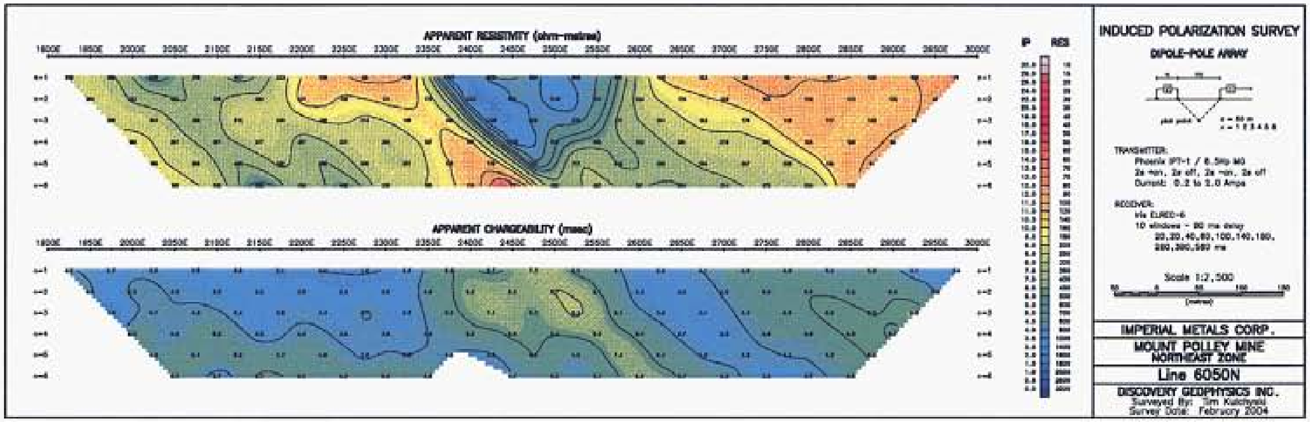
IMC
Associated Mining Consultants Ltd.

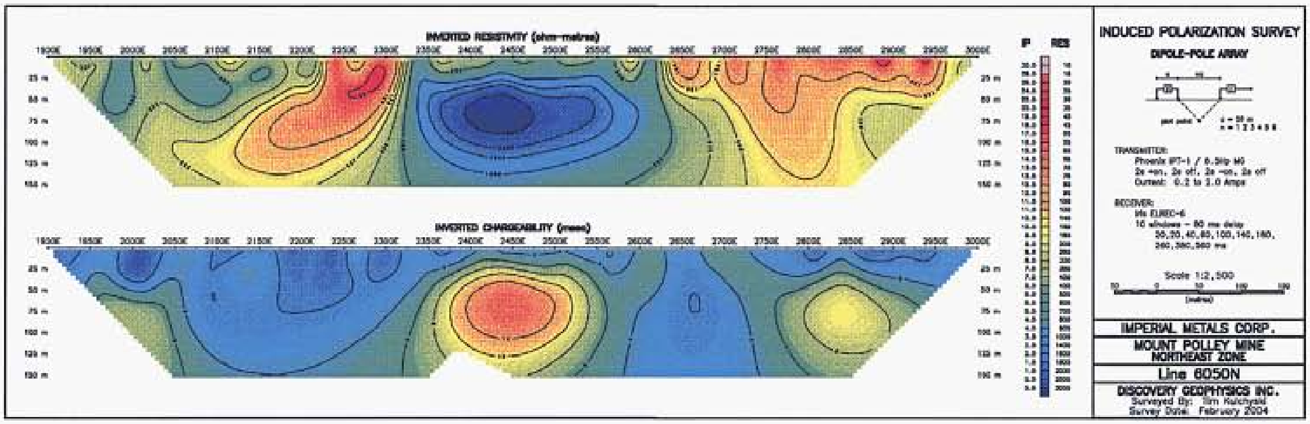


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 43: Line 6000, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.

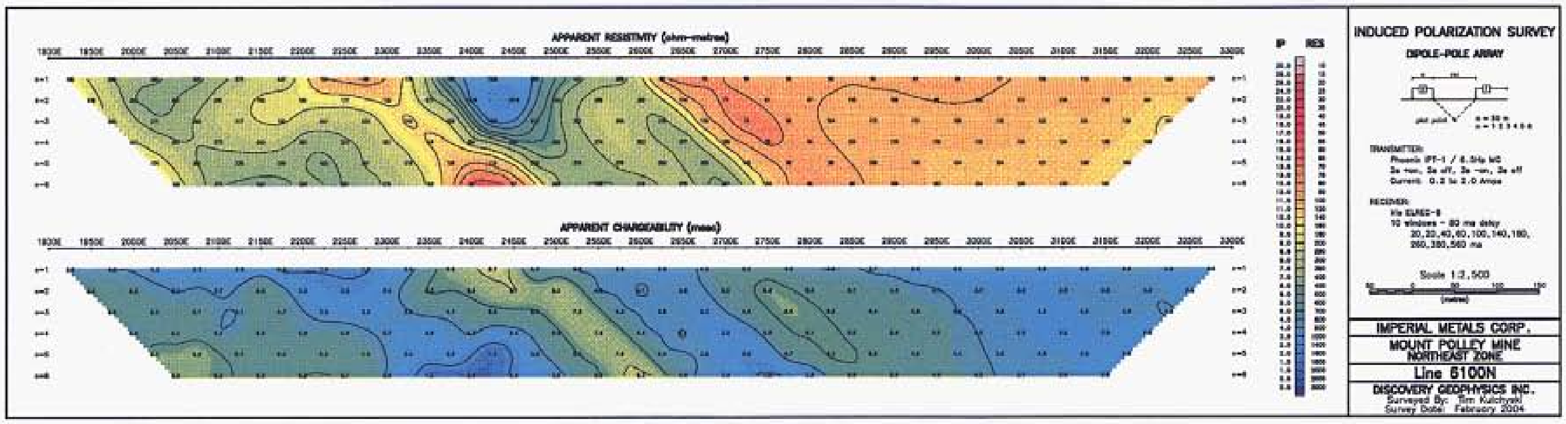


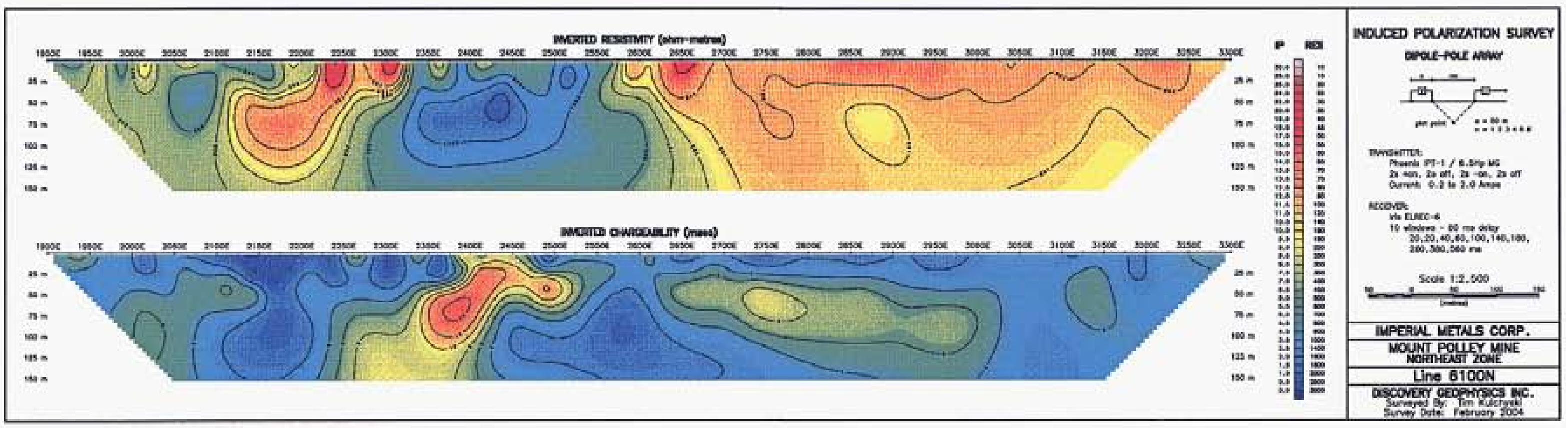


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 44: Line 6050, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.





Mount Polley Northeast Zone
Induced Polarization Survey

Figure 45: Line 6100, Pseudo-sections and Inversion Sections

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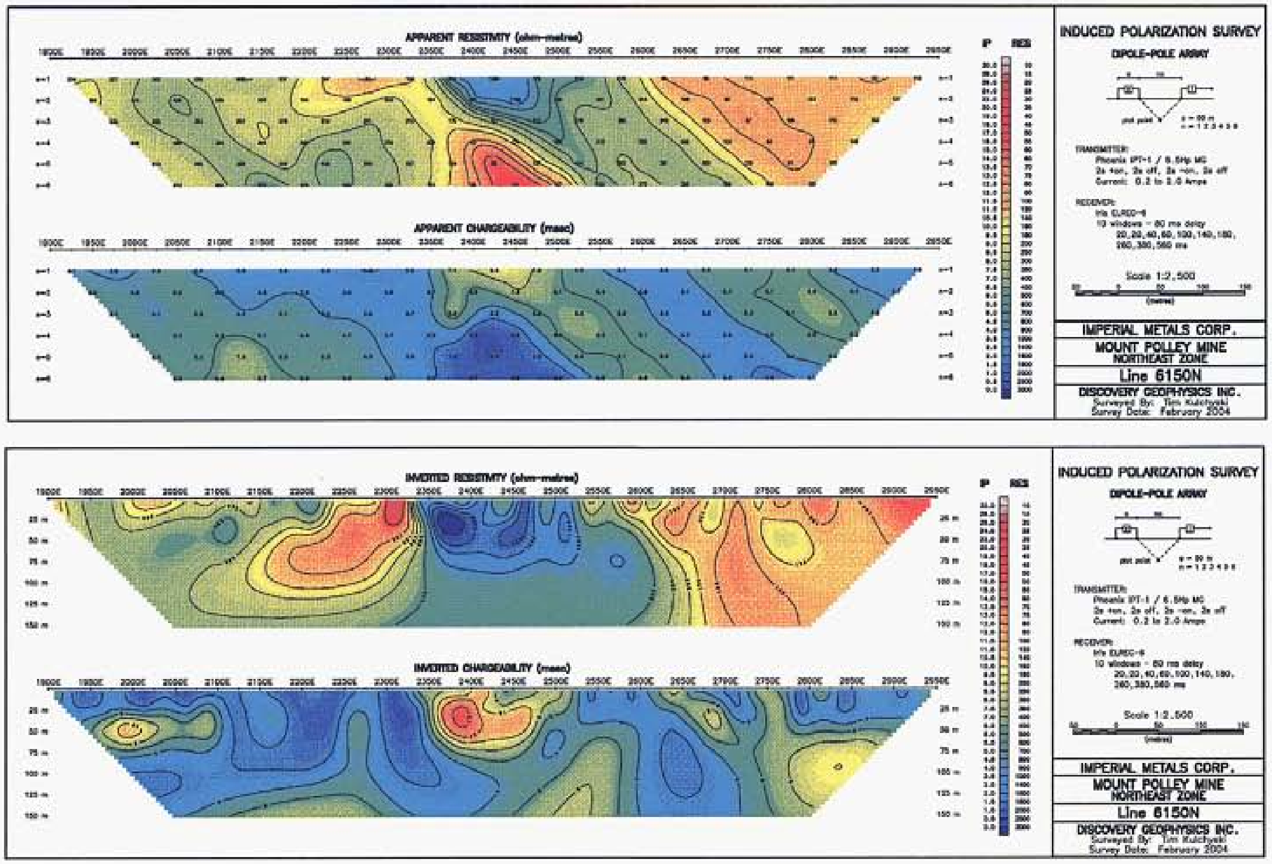

Mount Polley Northeast Zone
Induced Polarization Survey

Figure 46: Line 6150, Pseudo-sections and Inversion Sections

IMC
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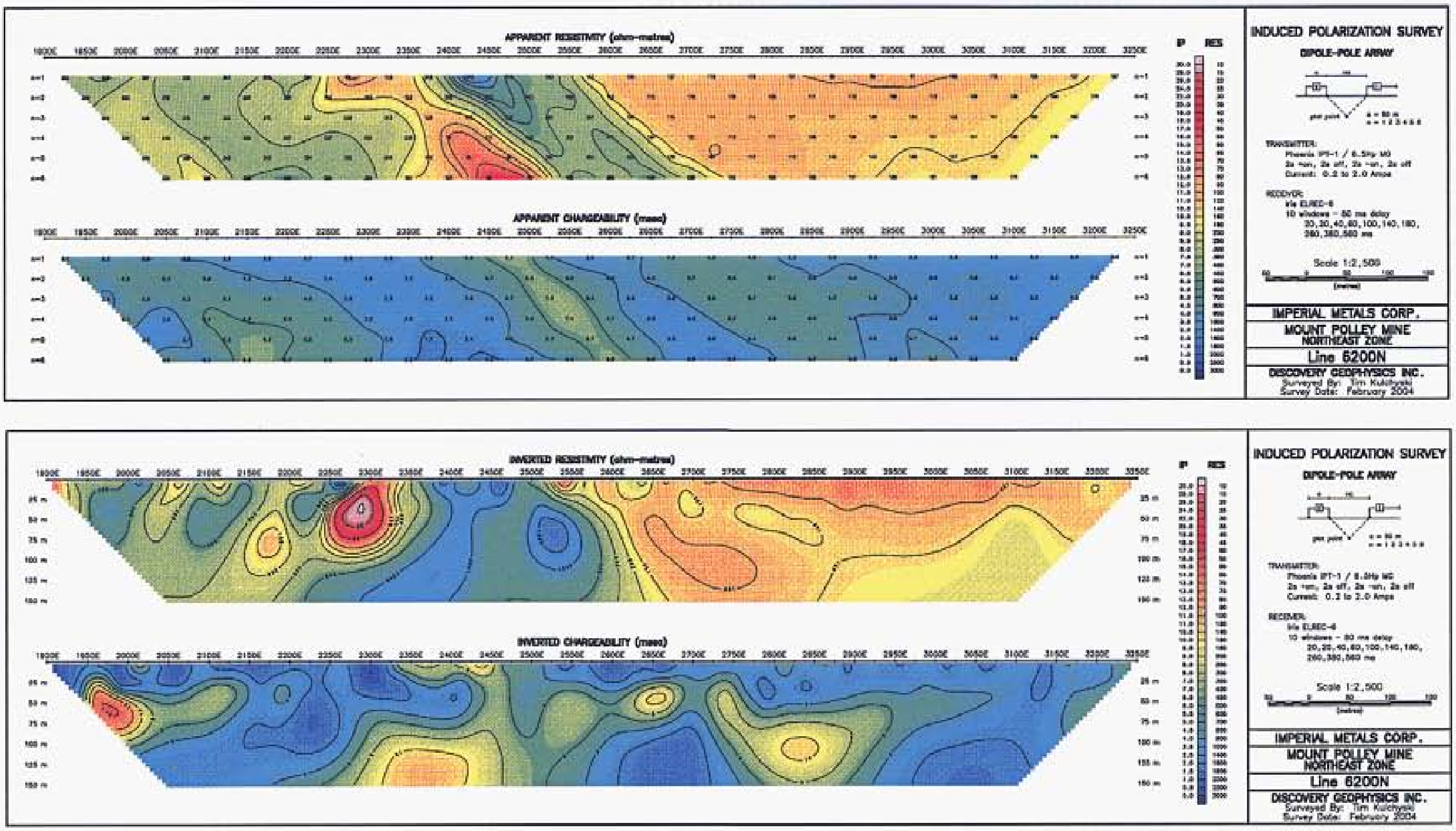
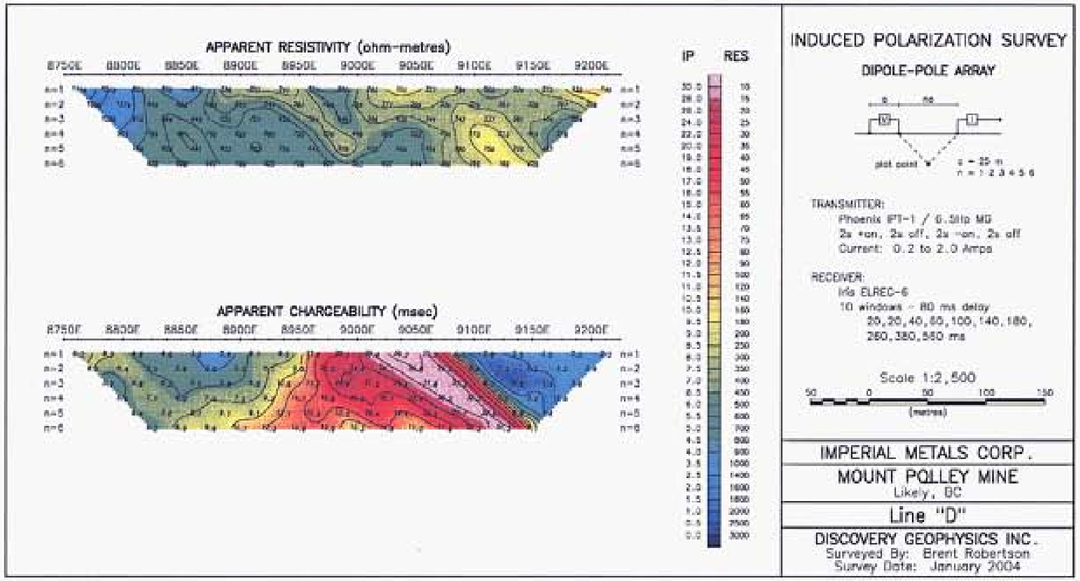
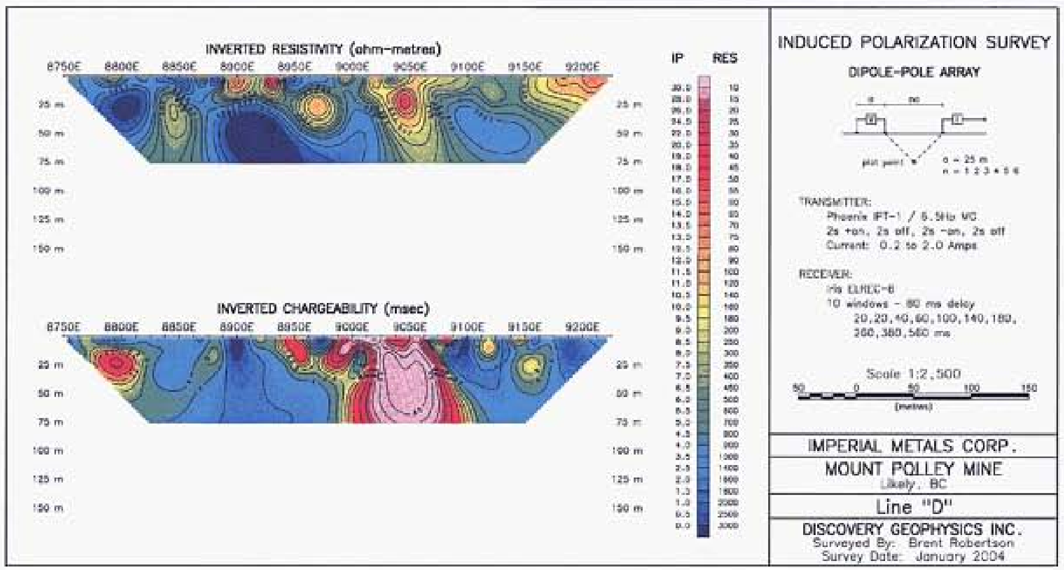


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 47: Line 6200, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.





Mount Polley Northeast Zone
Induced Polarization Survey

Figure 48: Test Line D, Pseudo-sections and Inversion Sections

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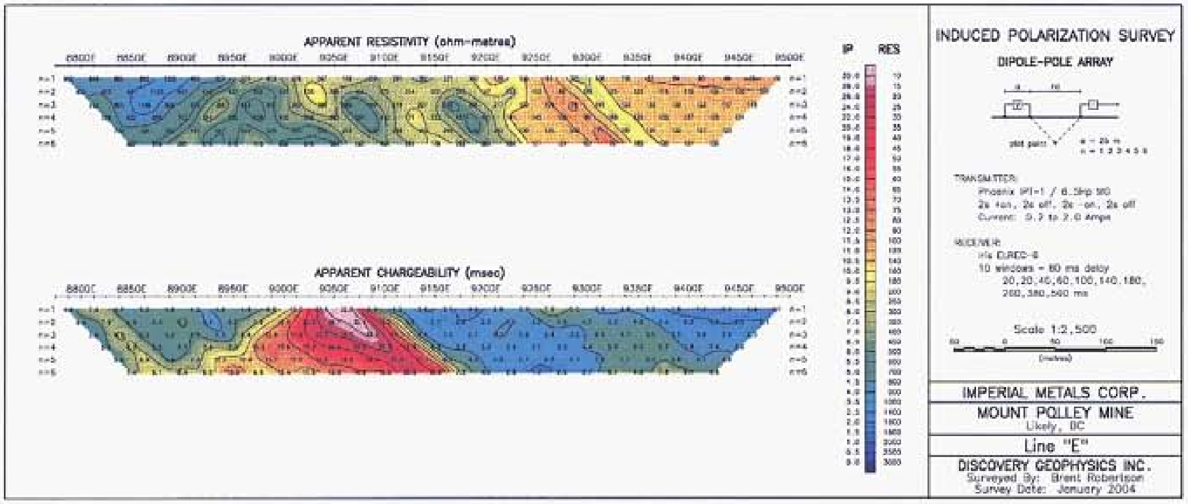
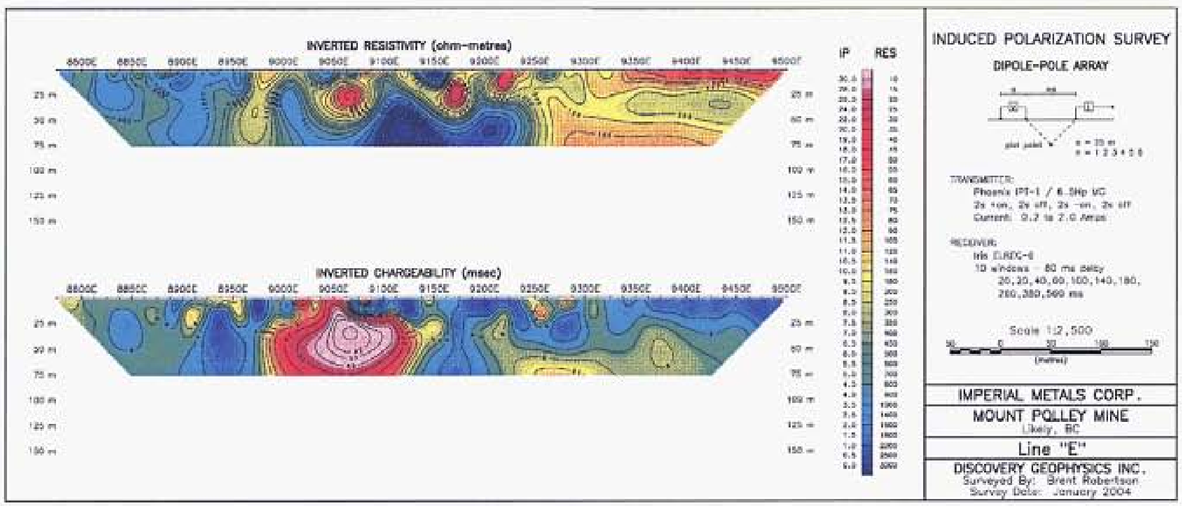
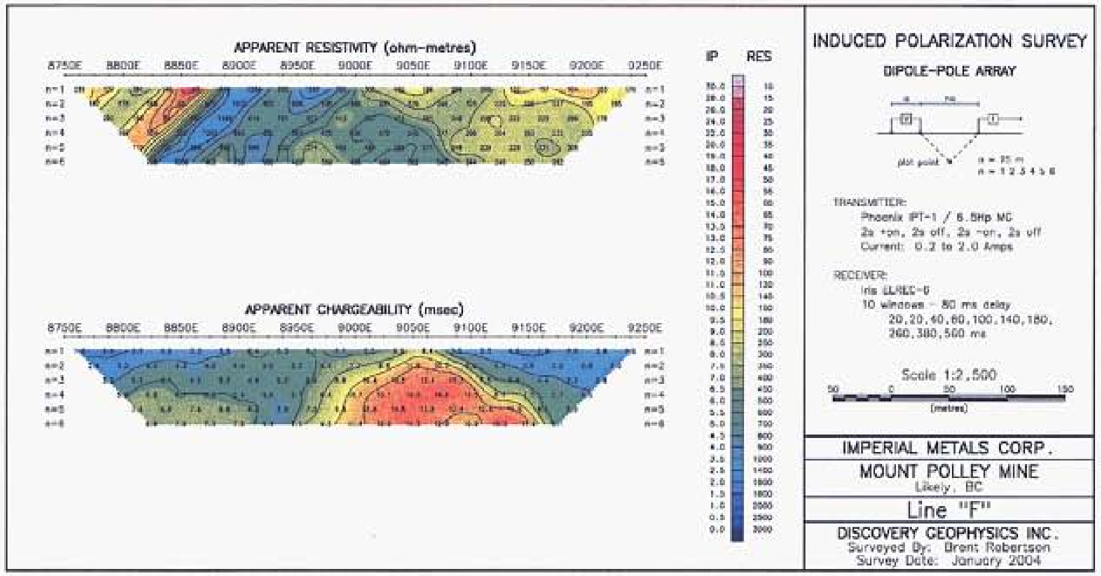


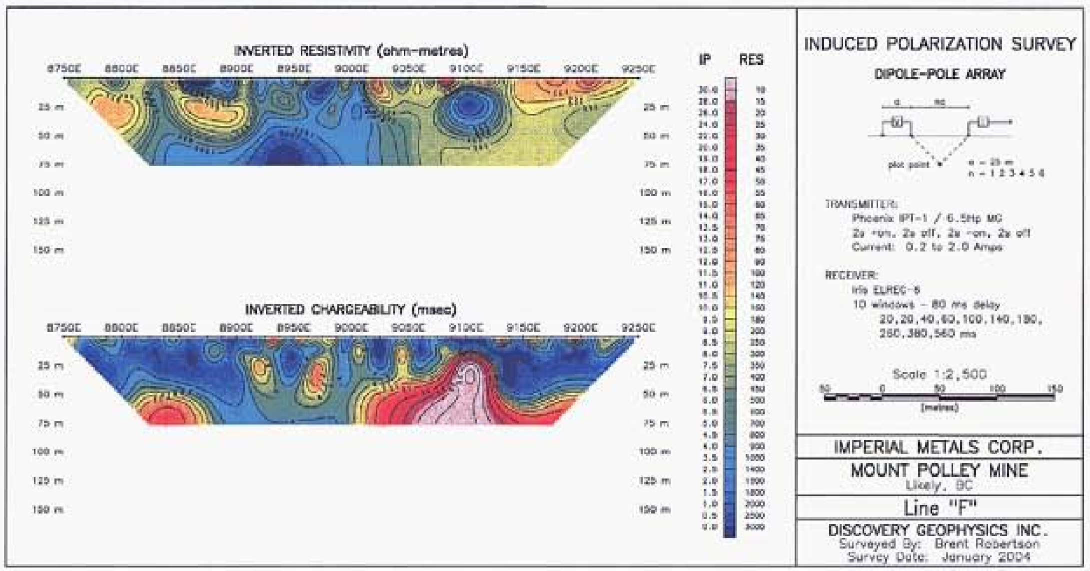


Mount Polley Northeast Zone
Induced Polarization Survey

Figure 49: Test Line E, Pseudo-sections and Inversion Sections

IMC
Associated Mining Consultants Ltd.





Mount Polley Northeast Zone
Induced Polarization Survey

Figure 50: Test Line F, Pseudo-sections and Inversion Sections

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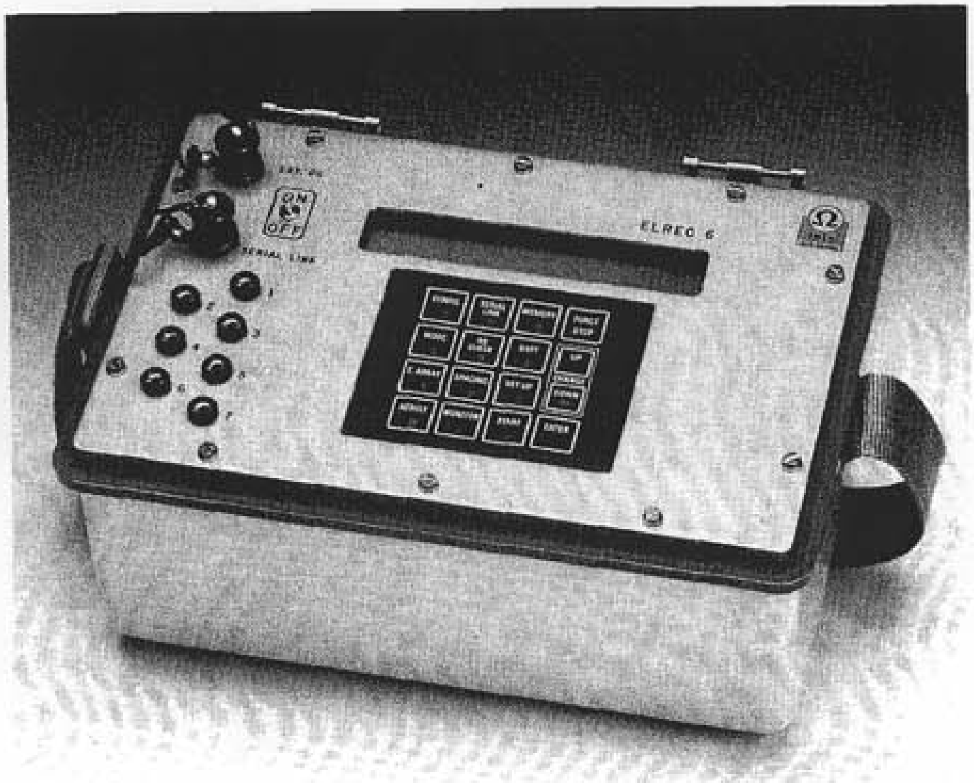
APPENDIX B

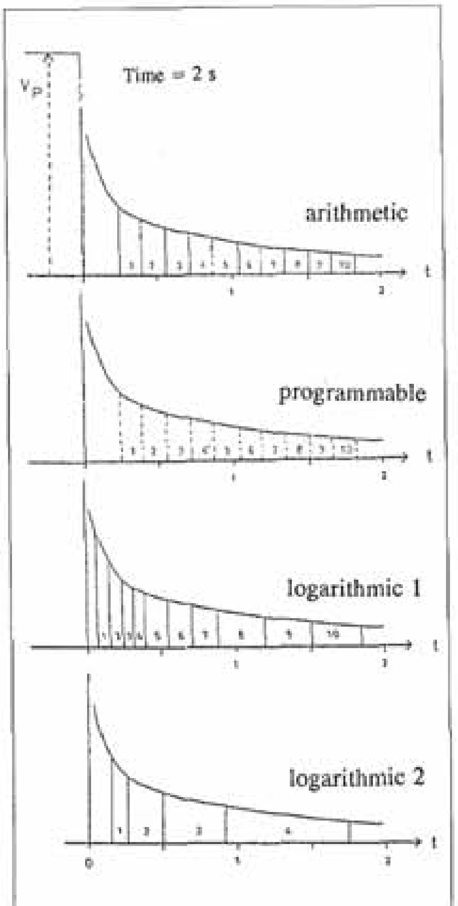
INSTRUMENTATION INFORMATION

ELREC 6

MULTI CHANNEL IP RECEIVER FOR MINERAL EXPLORATION



- **Six simultaneous dipoles**
- **Ten programmable chargeability windows**
- **High accuracy and sensitivity**



ELREC 6 SAMPLING MODES

ELREC 6 is a six dipole Time Domain Induced Polarization receiver designed for high productivity surveys in mineral exploration.

ELREC 6 has been designed for being both a user friendly and a very sensitive IP receiver.

ELREC 6 OUTSTANDING FEATURES

- **Six dipoles :**
  The six channels of the receiver permit to measure six dipoles simultaneously, which provides a high efficiency in the field.
- **Ten programmable windows :**
  Beside the classical preset logarithmic and arithmetic modes, **ELREC 6** also offers ten fully independant programmable windows which the operator can define by himself according to the way he wants to sample the IP decay curve.
- **Automatic measuring process :**
  A microprocessor fully controls the synchronization, the gain ranging, the stacking, and the display of the results including the apparent resistivity.
- **Monitoring display :**
  During the acquisition, the chargeabilities of the six dipoles can be displayed simultaneously on the LCD display for a global visualization of the readings ; the standard deviations of these chargeabilities can also be displayed simultaneously for a real time monitoring of the quality of the on going readings.
- **Internal memory :**
  The memory can store up to 2500 readings, each reading including the full set of parameters characterizing the measurements ; the date and time of the reading, given by the Real Time Clock of the instrument, are also stored. A serial link permits to transfer the data to a printer or a micro computer.
- **Remote control :**
  ELREC 6 can be fully driven by a micro computer through the serial link for remote operation applications.
- **Frequency mode :**
  The frequency effect and the phase shift between the fundamental and the third harmonics can be measured for a Frequency Domain waveform (ON +, ON -), or for a Time Domain waveform (ON +, OFF, ON -, OFF).
- **Field proof Instrument :**
  ELREC 6 operates in a wide temperature range and features a fiber-glass case for resisting to field shocks and vibrations.

IRIS Instruments

IRIS INSTRUMENTS - 1, avenue Buffon - B.P. 6007 - 45060 Orléans Cedex 2, France - Phone : (33) 38.63.81.00 - Fax : (33) 38.63.81.82

ELREC 6 MEASURING PROCESS

ELREC 6 measuring process has been optimized to provide the best possible accuracy in real field conditions.

ELREC 6 features :

- **A noise monitoring system :** A monitor function enables the operator to check the level of noise observed on each dipole before the measurement : the digital voltmeter function displays on the LCD the raw instantaneous value of potential. In particular, it is possible to numerically observe the presence of a pulse square waveform corresponding to a primary voltage signal and showing the operation of a transmitter. This function is also available during the acquisition of a reading.
- **A line check/ground resistance** measurement which permits to check that all seven electrodes are properly connected to the receiver.
- **A low-pass analog filter** which reduces the effect of higher frequency natural and cultural noises (50-60 Hz).
- **Automatic SP compensation**, including linear drift correction (up to 1 mV/s) through a digital filter.
- **Automatic gain ranging**, within a voltage range of ± 10V.
- **Automatic synchronization process : ELREC 6** automatically synchronizes with the signal through a waveform recognition process ; besides it automatically resynchronizes at each new pulse to avoid errors due to a possible shift in the period of the transmitted signal.
- **Automatic digital stacking** to enhance the signal-to-noise ratio for as long as the operator wants, with a maximum of 250 stacks. During the stackings, the operator can monitor either the instantaneous value (to observe the level of noise), or the cumulative value (to observe the convergence of the average value).
- **A continuous quality test procedure,** which stops the averaging process when the noise level becomes too high, but keeps the previously stacked data. The averaging procedure starts again when noise decreases. This procedure optimizes the time of data acquisition in very noisy areas.
- **A resolution after stacking** of 1 μ V for primary voltage, and of 0.01 mV/V for chargeability, for pointing out low amplitude anomalies. The standard deviations of the chargeability of the six dipoles are displayed during and after the acquisition to give an indication on the noise level.
- **A Normalized chargeability option :** The Normalized chargeability option refers the chargeability to a standard IP decay curve, and permits to point out any EM coupling effect on the measured signal.

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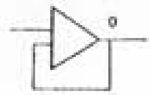
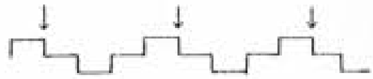
B.P. 6007 - 45060 Orléans Cedex 2, France
Phone : (33) 38.63.81.00
Fax : (33) 38.63.81.82

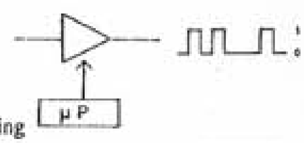


Automatic calibration



Automatic synchronization

SP compensation



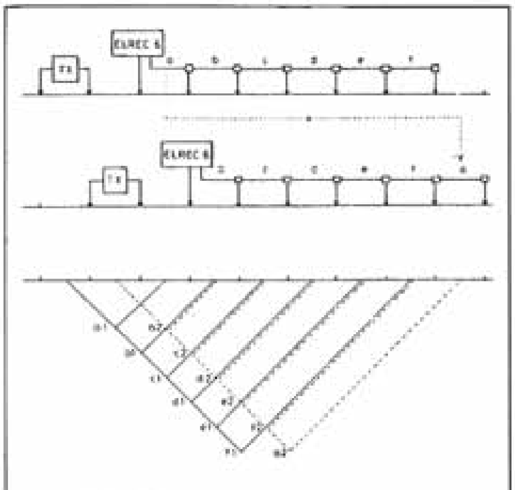
Digital ranging

$$\frac{SIGNAL}{NOISE} \sim \sqrt{N}$$

Digital stacking

$$(\sum(\bar{M} - M_i)^2 / N)^{1/2}$$

Standard deviation



DIPOLE DIPOLE MEASUREMENTS WITH ELREC 6 RECEIVER

SPECIFICATIONS :

- Six input channels.
- Signal waveform : Time Domain (ON +, OFF, ON -, OFF) with pulse duration of 0.5, 1, 2, 4, 8 seconds.
- Up to ten arithmetic, logarithmic, or fully programmable IP chargeability windows.
- Computation of apparent resistivity, average chargeability and standard deviation.
- Input impedance 10 Mohms.
- Input overvoltage protection up to 1000 volts.
- Input voltage range : each dipole : 10 V max sum of voltage of dipoles 2 to 6 : 15 V max.
- Automatic SP bucking ± 10 V with linear drift correction up to 1 mV/s.
- 20 bits $\Sigma\Delta$ converters.
- 50 to 60 Hz power line rejection.
- Sampling rate : 10 mS.
- Common mode rejection : 100 dB (for RS = 0).
- Grounding resistance measurement from 0.1 to 467 Kohms.
- Battery test : manual and automatic before each measurement.
- Primary voltage : resolution : 1 μ V after stacking accuracy : typ. 0,3 %.
- Chargeability : resolution : 0.01 mV/V accuracy : typ. 0,6 %.
- Memory capacity : 2500 readings.
- RS 232 link for data transfer to micro computers and printers (300 to 19200 bauds rate).
- Remote control through the serial link.

FREQUENCY MODE

- Signal waveform : (ON +, ON -) or (ON +, OFF, ON -, OFF).
- Pulse duration : 1s or 2s.
- Frequency effect and relative phase of fundamental and third harmonics.
- Resolution : about 0,01 degree after stacking.

GENERAL FEATURES :

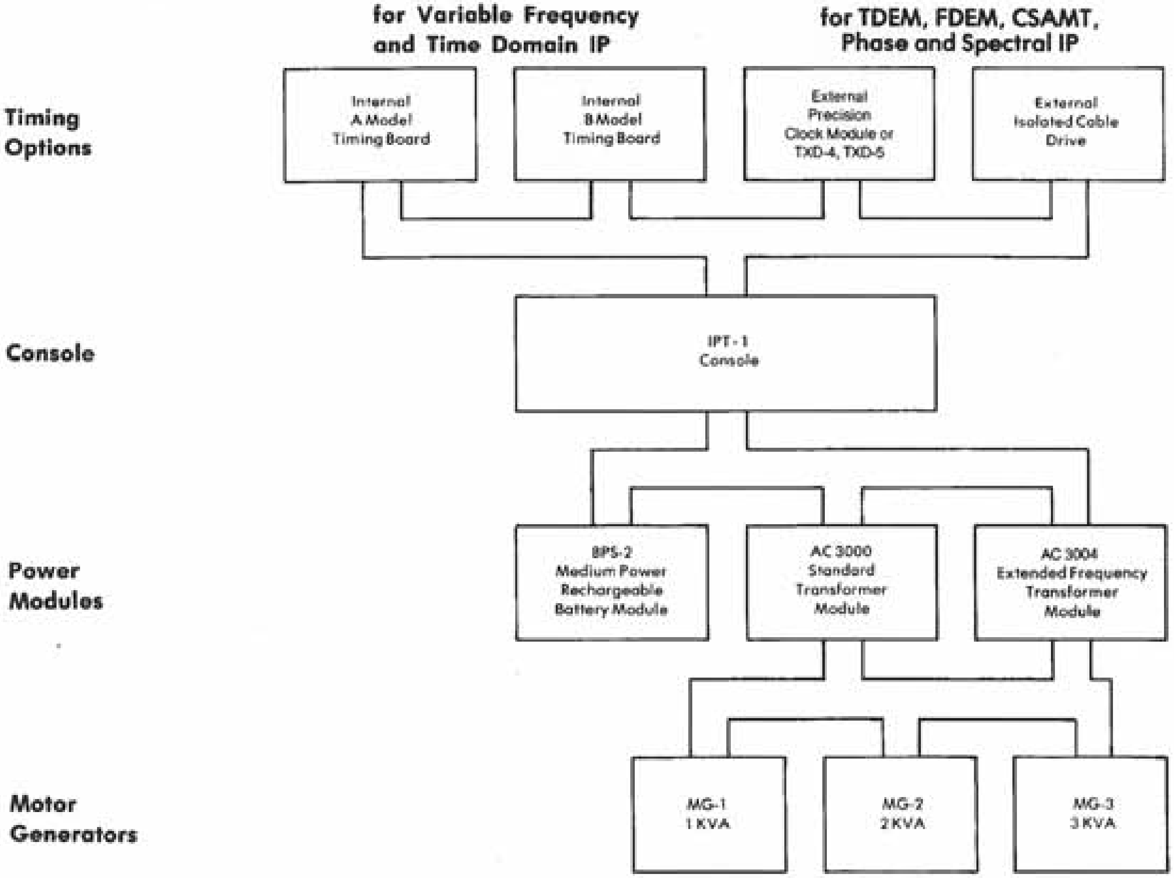
- Dimensions : 31 x 21 x 21 cm.
- Weight : 8 kg with internal battery. (6 kg with dry cells).
- Operating temperature : - 40° C to + 70° C.
- Power supply : 12 V internal battery, (six 1,5 V D size dry cells, optional). In both cases, a 12 V external battery can also be used.

IPT-1

Variable Frequency Transmitter for Time Domain and Phase IP, TDEM, FDEM, CSAMT

- Reliable: Backed by thirty years experience in the design and worldwide operation of induced polarization and resistivity equipment
- Versatile: Can be used for resistivity, variable frequency IP, time domain IP, phase angle IP measurements; with AC3004 module for TDEM, FDEM, CSAMT
- Stable: Excellent current regulation
- Lightweight, portable
- Wide selection of power sources
- Low cost

Transmitter Configurations



PHOENIX

PHOENIX GEOPHYSICS LIMITED

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Tel.: (416) 477 - 8588 Fax: (416) 477 - 9231 Telex: 06 - 986856 PHEXCO MKHM

Timing Options

INTERNAL TIMING BOARD

There are three available internal timing boards. All have the same internally-mounted crystal oscillator with a stability of 50 PPM over the temperature range -40°C to +60°C.

Model A :

STANDARD FREQUENCY SERIES
Frequency domain mode
±DC, .062, .125, .25, 1, 2 and 4 Hz.
Time domain mode
2 sec +, 2 sec off, 2 sec -, 2 sec off.
Simultaneous transmission mode
.25 and 4.0 Hz standard, other pairs available.

OPTIONAL FREQUENCY SERIES (change link on board)
Frequency domain mode
±DC, .078, .156, .313, 1.25, 2.5, and 5.0 Hz.
Time domain mode
1.6 sec +, 1.6 sec off, 1.6 sec -, 1.6 sec off.
Simultaneous transmission mode
.313 and 5.0 Hz standard, other pairs available.

Model B : The main difference between this timing board and the model A board is that the duty cycle is variable. Frequency domain operation is obtained by setting the duty cycle to 100% and selecting any of nine binary frequencies from 1/64 Hz to 4 Hz. Various time domain waveforms may be obtained by choosing any of the nine frequencies and a duty cycle of 25%, 50% or 75%. The standard 2 sec +, 2 sec off, 2 sec -, 2 sec off time domain waveform is chosen by selecting a duty cycle of 50% and a frequency of .125 Hz.

Model C : Time domain: 1, 2, 4, 8 second cycle. Frequency domain: 0.1, 0.3, 1.0, 3.0 Hz.

EXTERNAL TIMING SOURCES

The IPT-1 may be driven by external timing modules. Phoenix supplies the TXD-3 high precision clock module (stability 10^{-7}/day, or 2.26 mrad/hr at 1 Hz) for use in phase IP. For CSAMT or Time Domain IP, Phoenix offers the TXD-4 and TXD-5 modules. These have a lower precision than the TXD-3, since extremely high frequency and phase stability is not required for either CSAMT or TDIP.

EXTERNAL ISOLATED CABLE DRIVE

The isolated cable drive option allows the IPT-1 to be driven by the timing circuitry of the V4 or V5 receivers. The maximum distance allowed between transmitter and receiver is 500m. For efficient spectral IP field surveying, the distance between the transmitter and receiver is always maintained at one electrode interval. Thus the maximum convenient electrode interval, using the isolated cable drive option, is 500m. The V4 measures the current plus seven voltage dipoles (n = 1,7) simultaneously.

Console

Ammeter Ranges : 30 mA, 100 mA, 300 mA, 1A, 3A and 10A full scale.

Meter Display : A meter function switch selects the display of current level, regulation status, input frequency, output voltage, control voltage and line voltage. An optional digital display presents all of the above, plus external circuit resistance.

Current Regulation : The change in output current is less than 0.2% for a 10% change in input voltage or electrode impedance.

Protection : The current is turned off automatically if it exceeds 150% full scale or if it is less than 5% full scale.

Internal Power Modules

BPS-2 RECHARGEABLE BATTERY POWER MODULE

Output Voltage	:	50V, 106V, 212V, 425V, and 850V.
Output Current	:	3 mA to 3A.
Output Power	:	Maximum output power is 300 watts. Above this output power a protective cut-out is engaged to prevent battery and circuit damage.
Batteries	:	4 x 12V rechargeable gell cell batteries connected in series/parallel have a capacity of 9 A-hr. External batteries (such as car or motorcycle batteries) may also be used. A special cord and plug are provided for this mode of operation. An adaptor cord connects the 12V batteries in parallel with the 12V charging unit.
Operating Temperature	:	-40°C to +60°C. Below 0°C the capacity of the batteries is significantly reduced (by 70% at -40°C).

AC 3000 TRANSFORMER POWER MODULE

Output Voltage	:	75V, 150V, 300V, 600V and 1200V.
Output Current	:	3 mA to 10A (max.)
Output Power	:	Maximum continuous output power is 3KW with MG-3 motor generator, 2KW with MG-2 motor generator and 1KW with MG-1 motor generator.
Input Power	:	Three phase, 400 Hz (350 to 1000 Hz), 60V (50V to 80V) is standard. Three phase, 400 Hz (350 to 1000 Hz), 120V (100V to 160V) is optional.
Current Regulation	:	Achieved by feedback to the alternator of the motor generator unit.
Operating Temperature	:	-40°C to +60°C.
Thermal Protection	:	Thermostat turns off at 65°C and turns back on at 55°C internal temperature.

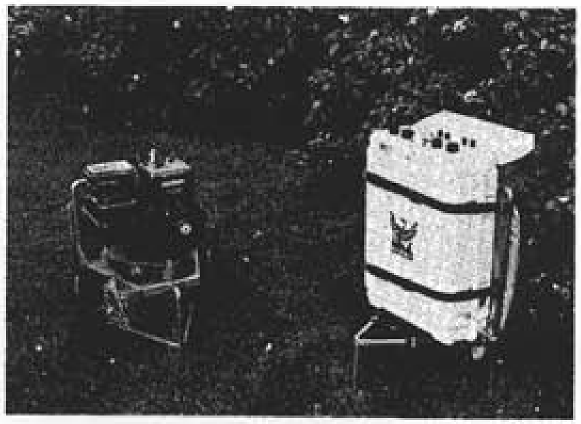
AC 3004 TRANSFORMER POWER MODULE

Same as AC 3000 except for:

Output Voltage	:	60V, 150V, 300V, 600V, 800V (max.)
Frequency Range	:	DC to 8192 Hz under external drive (all other power modules have a maximum frequency of 5 Hz).

General

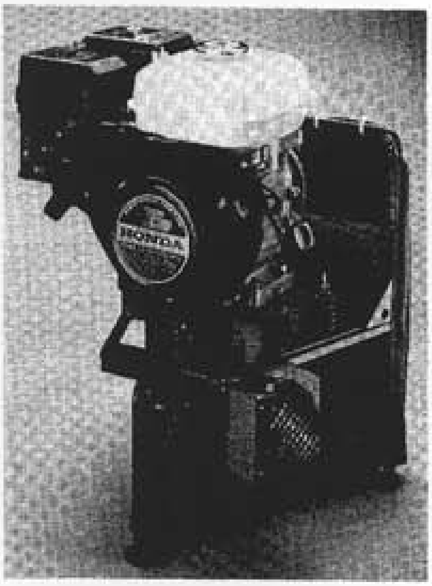
Dimensions	:	20 x 40 x 55 cm (9 x 16 x 22 in).
Weight	:	13 kg (29 lb) with BPS-2. 17 kg (37 lb) with AC-3000. 18 kg (40 lb) with AC-3004.
Standard Accessories	:	Pack frame, manual, At least one of the four possible power modules is required. The transformer power modules in turn require one of the three external 1KVA, 2KVA, 3KVA, motor generators and a connecting cable.



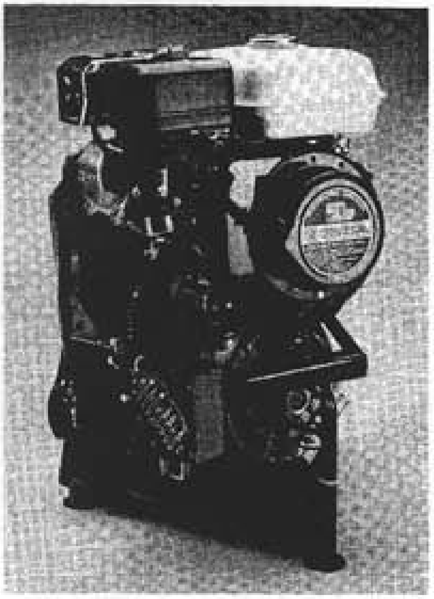
Motor Generators

There are three motor generators, differing in weight and power, which can be used with the transformer power modules. All three supply three phase, 400 Hz (350 to 600 Hz), 60V (45V to 80V). The voltage is regulated by feedback from the transmitter.

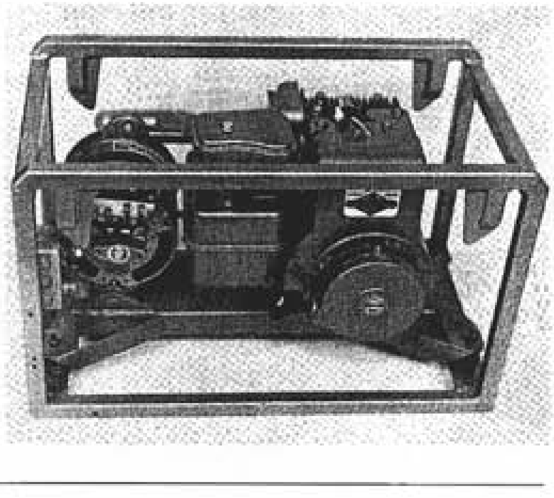
MG - 1 : This lightweight unit is designed for easy portability in areas of moderately high resistivity. It is well suited for massive sulfide exploration in Northern Canada, Europe and Asia, as well as general IP and resistivity surveys in rugged, mountainous areas around the world. The motor is a 4-cycle Honda which produces 3 HP at 3600 rpm. The dimensions of the unit, including packframe, are 40 x 45 x 60 (16 x 18 x 24 in). Total weight is 25 kg (55 lb.).



MG - 2 : 2KVA motor generator. This versatile unit is adequate for the vast majority of IP and resistivity surveys conducted worldwide. It is light enough to be carried by one man, yet powerful enough for most survey requirements. The motor is a 4-cycle Honda which produces 5 HP at 3600 rpm. The dimensions of the unit, including packframe, are 40 x 45 x 60 cm (16 x 18 x 24 in). Total weight is 34 kg (75 lb).



MG - 3 : 3KVA motor generator. This two-man portable unit is designed for surveys in areas which require additional power. The motor is a 4-cycle Briggs and Stratton which produces 8 HP at 3600 rpm. The unit is mounted in a square frame with dimensions 40 x 48 x 75 cm (16 x 19 x 29) in). Total weight is 55 kg (120 lb).



- Designed for groundwater and mineral exploration, and for geo-engineering applications, continuing the concepts of the earlier and highly popular MaxMin models.
- Frequency span is extended to eight octavely spaced frequencies from 110 to 14080 Hcreased range and number of coil separations. These and other developments result in greater performance with more applications and enhanced interpretation.
- Advanced spheric and powerline interference rejection is still further improved, resulting in more accurate surveys, particularly at the larger coil separations.
- MaxMin Computer or MMC, which is described in a separate data sheet, is offered for processing, display, storage and transfer. The MMC displays and stores the in-phase quadrature readings, their standard deviations, and the corresponding apparent conductivity values. Rough terrain surveys are also simplified with the MMC.
- Data interpretation and presentation programs are available for layered earth parametric soundings and discrete conductor surveys done with MaxMin EM.

- The MMC interfaces with MaxMin EM System receivers for digital data processing, display, storage and transfer, enhancing survey productivity and data accuracy.
- Digital display and logging of in-phase (real) and quadrature (imaginary) readings with standard deviations, the corresponding apparent ground conductivity values, line, station, terrain slope and coil tilt information.
- Easy fingertip operation by read and store switches on MaxMin receiver front panel, with digital averaging for improved signal to noise ratio,
- Rough terrain surveys are simplified with the use of built-in tilt meter, slope entry and computed coil orientation and separation information.
- Data transfer, formatting, correction and viewing programs are supplied for personal computers. Program for computing multi-frequency best-fit apparent conductivities and fit errors is provided.
- Data interpretation and presentation programs are available for multi-layer parametric or geometric soundings and discrete conductor surveys done with MaxMin EM.

MAXMIN I-8 ELECTROMAGNETIC SYSTEM SPECIFICATIONS:

FREQUENCIES:	110, 220, 440, 880,1760, 3520, 7040 & 14080 Hz.
COIL SEPARATIONS:	SET NO. 1: 12.5, 25, 50, 75, 100, 125, 150, 200, 250, 300 and 400 metres (the standard set). SET NO. 2: 10, 20, 40, 80, 100, 120, 160, 200, 240, and 320 metres (selected with grid switch in receiver). SET NO. 3: 50, 100, 200, 300, 400, 500, 600 and 800 feet 12.5, 25, 50, 75, 100, 125, 150, 200, 250, 300 and 400 metres (selected with grid switch in receiver).
TRANSMITTER DIPOLE MOMENTS:	110 Hz: 220 Atm^2 1760 Hz: 160 Atm^2 220 Hz: 215 Atm^2 3520 Hz: 80 Atm^2 440 Hz: 210 Atm^2 7040 Hz : 40 Atm^2 880 Hz: 200 Atm^2 14080 Hz: 20 Atm^2
MODES OF OPERATION:	MAX 1: Horizontal loop or slingram - transmitter and receiver coil planes horizontal and coplanar MAX 2: Vertical coplanar loop mode transmitter MIN 1: Perpendicular mode 1 - transmitter coil plane horizontal and receiver coil plane vertical. MIN 2: Perpendicular mode 2 - transmitter coil plane vertical and receiver coil plane horizontal.
PARAMETERS MEASURED:	In-phase and quadrature components of the secondary magnetic field, in % of primary field
READOUTS:	Analog direct edgewise meter readouts for in phase, quadrature and flit. Additional digital LCD readouts provided in the optional MMC computer. Interfacing and controls are provided for ready plug-in of the MMC.
RANGES OF READOUTS:	Switch activated analog in-phase and quadrature 0 scales: 0±4%, 0±20 % and 0±100 %, and digital 0±199.9% autorange with optional MMC. Analog tilt 0±75 % and 0±99 % grade with MMC.
RESOLUTION:	Analog in-phase and quadrature 0.1 to 1 % of primary field, depending on scale used, digital 0.01 % with autoranging MMC; tilt 1 % grade,
REPEATABILITY:	0.01 to 1 % of primary field, typical, depending on frequency, coil separation and conditions.
SIGNAL FILTERING:	Powerline comb filter, continuous spheric noise clipping, auto-adjusting time constant, and more.
WARNING LIGHTS:	Receiver and reference warning lights to indicate potential error conditions.

SURVEY DEPTH PENETRATION:	From surface down to 1.5 times coil separation for large horizontal target and 0.75 times coil separation for large vertical target, values typical.
REFERENCE CABLE:	Lightweight unshielded 4/2 conductor teflon cable for maximum operating temperature range and for minimum pulling friction.
INTERCOM:	Voice communication link provided for operators via the reference cable.
TEMP. RANGE:	Minus 40 to plus 60 degrees Celsius, operating.
RECEIVER BATTERIES:	Four standard 9 V - 0.6 Ah alkaline batteries. Life 25 hours continuous duty, less In cold weather. Optional 1.2 Ah extended life lithium batteries available (recommended for very cold weather).
TRANSMITTER BATTERIES:	Standard rechargeable gel-type lead-acid 12 V - 13 Ah 14 Ah batteries (4 x 6V - 6.5 Ah) in nylon beltpack. Optionally rechargeable long life 12 V - 14 Ah nickel-cadmium batteries (20 x 1.2 V - 7 Ah) with Ni-Cad chargers - best choice for cold climates.
TRANSMITTER BATTERY:	Lead acid battery charger: 14.4 V @ 1.25 A, Ni-Cad battery charger: 1.4 A @ 16 V nominal output. Operation from 110 - 120 and 220 - 240 VAC, 50 -60 Hz, and 12 - 15 VDC supplies.
RECEIVER WEIGHT:	8 Kg carrying weight (including the two ferrite cored antenna coils), 9 Kg with MMC computer.
TRANSMITTER WEIGHT:	16 Kg carrying weight.
SHIPPING WEIGHT	60 Kg plus weight of reference cables at 2.8 Kg per 100 metres, plus optional items if any. Shipped in two aluminum lined field / shipping cases.
STANDARD SPARES:	Spare transmitter battery pack, spare transmitter battery charger, two spare transmitter retractile connecting cords, spare set of receiver batteries.
OPTIONS AND ACCESSORIES	- MMC, MaxMtn Computer option - Data interprellation and presentation programs - Reference cables, lengths as required - Reference cable extension adapter - Handheld inclinometer for rough terrain - Receiver extended life lithium batteries - Transmitter Ni-Cad battery & charger options - Minimal, regular or extended spare parts kit

MAXMIN COMPUTER MMC SPECIFICATIONS:

OPERATING SYSTEM:	Menu driven user-friendly hierarchial operating system, interfacing with MaxMin EM System receiver and with personal computers.
DISPLAY:	Liquid Crystal Display, with two lines of 24 alphanumeric characters each.
KEYBOARD:	18 tactile push-button keys
BEEPER:	To provide audible operator guidance and to speed up operations, especially in very cold weather,
CLOCK CALENDAR:	Date and Time (year, month, day, hour and minute)
COIL TILT:	Tilt display, with built in tilt sensor and circuitry. with 0±99% grade range and with 1% resolution
IN-PHASE & QUADRATURE:	0±199.9% auto-ranging programmable gain system with 0.1% resolution for displayed data and 0.01% resolution for stored data
APPARENT CONDUCTIVITY:	0.1 to 3276 milliSiemens (millimho) per metre available conductivity range, with conductivity arrived at using the quadrature, in-phase, frequency and coil separation data
PROCESSOR:	16 bit low power CMOS CPU and bus at 6 MHz clock rate
MEMORY:	ROM: 16 Kb, expandable to 64 Kb RAM: 256 Kb, static CMOS
PHYSICAL SIZE:	24.2 x 17.3 x 4.3 cm, to fit inside MaxMin receiver leather case notebook pocket.
WEIGHT:	1.0 Kilogram
BATTERIES:	Two 9 Volt- 0.57 Ampere-hour alkaline batteries. Battery life 28 hours continuous duty, less in cold weather. Optional 1.2 Ah lithium batteries recommended for very cold weather operation. One lithium 3 Volt back-up battery, type 2032.
CONNECTIONS:	19 pin bayonet connector receptacle to connect to MaxMin receiver with the supplied aluminum tube connectors. One each of DB25S and DB9S data transfer cords supplied for downloading data to personal computer serial port.
TEMPERATURE RANGE:	Minus 30 to plus 60 degree Celsius. Temperature sensor and temperature display built-in.

GEONICS LIMITED
1745 Meyerside Dr. Unit 8 Mississauga, Ontario Canada L5T 1C6

Tel. (416) 670-9580
Telex 06-968688
Cables: Geonics

GEONICS PROTEM EM SYSTEM

TEM57 TRANSMITTER

TECHNICAL SPECIFICATIONS

Current Waveform	: Bipolar rectangular current with 50% duty cycle.
Repetition Rate	: 3 Hz, 7.5 Hz or 30 Hz - in countries using 60 Hz power line frequency;
	: 2.5 Hz, 6.25 Hz or 25 Hz - in countries using 50 Hz power line frequency.
Turn-Off Time	: 115 µs at 20 amps into 5 x 5m square 8 turn loop.
Transmitter Loop	: Any dimension from 5 x 5m multiple turn (8 turn std) to 600 x 300m #10 single turn loop.
Output Current	: 20 amps maximum.
Output Voltages	: 20 volts and 40 volts.
Synchronization Mode	: (1) Reference cable : (2) High stability quartz crystal (optional)
Motor Generator	: 600 W / 120 V / 60 Hz / single phase
Transmitter Protection	: Electronic and electromechanical protection against short circuit.
Transmitter Size	: 42 x 20 x 31 cm.
Transmitter Weight	: 13 kg.
Motor Generator Size	: 44 x 32 x 21 cm.
Motor Generator Weight	: 21 kg.

June, 1990

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PLEASE NOTE OUR
NEW AREA CODE
TEL: (905) 670-9580
FAX: (905) 670-9204

GEONICS PROTEM EM SYSTEM
PROTEM DIGITAL RECEIVER
TECHNICAL SPECIFICATIONS

Measured Quantity	:	Time rate of decay of magnetic flux along 3 axes.
Sensors 1. (L.F.)	:	Air-cored coil of bandwidth 60 kHz; 100 cm diameter.
2. (H.F.)	:	Air-cored coil of bandwidth 850 kHz; 100 cm diameter.
3. (3D-3)	:	Three orthogonal component sensor; simultaneous operation.
4. (3D-1)	:	Three orthogonal component sensor; sequential operation.
Time Channels	:	20 geometrically spaced time gates for each base frequency gives range from 6 μs to 800 ms.
Repetition Rate (Base Frequency)	:	0.3 Hz, 0.75 Hz, 3 Hz, 7.5 Hz, 30 Hz, 75 Hz or 285 Hz for countries using 60 Hz power line frequency. 0.25 Hz, 0.625 Hz, 2.5 Hz, 6.25 Hz, 25 Hz, 62.5 Hz or 237.5 Hz for countries using 50 Hz power line frequency.
Synchronization	:	(1) Reference cable. (2) High stability quartz crystal (optional).
Integration Time	:	2, 4, 8, 15, 30, 60, 120, 240 sec.
Calibration	:	Internal self calibration External Q coil calibration (optional).
Keyboards	:	Two 3 x 4 matrix sealed key pads with positive tactile feedback.
Gain	:	Automatic or manual control.
Dynamic Range	:	23 bits (132 dB).